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ACADEMIC FREEDOM AND THE UNORTHODOX

PROF. A. MACBEATH, of the Queen's University, Belfast, delivered an evening discourse to the British Association last September, putting forward a plea for 'heretics' as he termed them; and his thoughtful diagnosis of the contemporary situation has been published in *The Advancement of Science* (vol. 9, No. 35; December 1952) almost simultaneously with the delivery of Dr. J. B. Conant's last report as president of Harvard University, on his appointment as United States High Commissioner to Germany. In that report Dr. Conant likewise stoutly champions the right to dissent, and threw the full weight of his authority against any large inquiry in the McCarthy spirit into teaching systems and courses of instruction in colleges and universities. Dr. Conant himself believes that Communists should be banned from appointments in any school, college or university, and supports the discovery and prosecution of any subversives. He is not opposed to security investigations even in the academic world, provided it is conducted with "due process of law"—and Prof. W. Gellhorn and Mr. Alan Barth's books have provided sufficient evidence that many investigations have failed to observe this condition or to be conducted with the restraint that is necessary to avoid doing more harm than good. Nevertheless, said Dr. Conant, "It would be a sad day for the United States if the tradition of dissent were driven out of the universities. For it is the freedom to disagree, to quarrel with authority on intellectual matters, to think otherwise, that has made this nation what it is. . . . An industrial society was pioneered by men who were dissenters . . . the global struggle with communism turns on this very point. . . . The independence of each college and university would be threatened if Government agencies of any sort started inquiries into the nature of the instruction that was given. The colleges of the United States have nothing to hide, but their independence as corporate scholarly organizations is of supreme importance".

Dr. Conant thus stands with his fellow countrymen, Prof. G. Boas, of Johns Hopkins University, and Prof. H. S. Commager, of Columbia, whose warnings against the growth of authoritarianism and championship of the claims of criticism and dissent and non-conformity are quoted by Prof. Macbeath as evidence that the friends of freedom in the United States are alert and active. Indeed, the appointment of Dr. Conant himself as High Commissioner for Germany, in spite of his outspoken defence of academic freedom, suggests that his actions are not unwelcome to the American Government. The attack on nonconformity may continue in the United States and elsewhere; but it is at least clear that a widespread body of responsible men and women will not tolerate in silence and without resistance the development of the kind of society in which freedom of inquiry, criticism and originality do not flourish.

Prof. Macbeath began his discourse by reminding his audience that by the beginning of this century

the freedom, which Milton with his sure insight recognized as the foundation of all other liberties and which is an essential condition of the advancement of science, seemed to be so thoroughly established that people tended to take it for granted as part of the natural order of things. To-day it is perhaps in greater danger than at any time since Milton wrote; and that dissent should be regarded as disloyalty, criticism as an unfriendly act, and difference of opinion as disaffection, show how far we have drifted towards authoritarianism and away from the free, frank and critical discussion of all questions which is the essence of democracy. Moreover, there are tendencies in the society which science has helped to produce which may slowly but surely destroy the spirit of free inquiry and produce a state of affairs in which science can no longer flourish.

The plea for 'heretics' was therefore essentially concerned with these factors in our contemporary society and with the causes which have produced them. Prof. Macbeath sees no evidence that the moral or intellectual qualities of our people have deteriorated. The conditions in which we live make greater demands on the intelligence, the imagination and the sympathy of our people, and as a result the people are bewildered, perplexed and unhappy. Although science has helped to produce it, this state of affairs is not an inevitable consequence of science or even of its application. Science has developed in the context of a society which provides its stimulus and inspiration and which provides the men who engage in it; and, rather than blame science, we should, if we wish to use wisely the power which science has placed at our disposal, seek to regain and retain our hold on the disintegrating factors in the situation.

This position must not be attributed merely to the wilfulness or wickedness of any group of men, and we cannot solve our problem by neglecting one half of life when we find reconciliation with the other difficult. Indeed, Prof. Macbeath laid his main stress on the need for sincerity—for acting on principles to which we are apt to render merely lip service. Much of the frustration and malaise in modern life are due to this discrepancy between our profession and our practice. If a principle is sound, the proper way is to act on it; to revitalize our society we need to reformulate the platitudes, to which we assent but in which we do not believe, and embody them in our institutions and way of life in such a manner that they would be true in theory and apply in practice.

The two most characteristic movements of the modern age, said Prof. Macbeath, are science and democracy. Both spring from respect for the dignity of man as an intelligent being. Both stand for what Plato called the victory of persuasion over force, of discussion over dictation, and both are tentative and experimental, rejecting all claims to dogmatic authority or certainty.

For three centuries men have been trying to embody their faith in this new attitude in institutions and a way of life. During the present century the presuppositions of both science and democracy have been challenged and they are called upon to defend themselves; this has been due mainly to technology and industrialism. It is these features of the modern age, he believes, which have produced the state of affairs threatening to destroy the scientific spirit to which they owe their origin.

In the modern world, science owes its prestige mainly to the power over his environment which it places at man's disposal. That power can be used for good or for evil, and when men found by bitter experience that it was not always wisely used, they reacted not only against freedom to misuse it but also against freedom in general. Such reaction is due at least in part to a confusion between science and the results of its application, and a consequent failure to distinguish between the freedom which is a necessary condition of scientific discovery and progress, and the control which has to be exercised over the use made of the results of applied science if they are to contribute to the welfare of man, and not to his undoing. It was also a confusion between what science does and what it does not profess to do, which has led men to expect of science not only knowledge and power but also the wisdom to use it aright.

To these results must be added a natural resistance on the part of the ordinary man to the scientific attitude. It requires a long training and a hard discipline to eradicate the expectation that there exists a body of fixed and certain truth to be accepted as final, and to secure acceptance of the scientific viewpoint according to which all conclusions are on trial and the function of the mind is to be for ever reaching-out and for ever learning and testing. Moreover, the scientific attitude is opposed to some of the settled tendencies of human nature, involving the co-operation of men of different classes and countries, in contrast to the relatively small groups to which many of our traditional, emotional and social habits and institutions have become adapted. This resistance has also been greatly intensified by the changes which scientific techniques have introduced into the modern world. While science and democracy promise him a greater mastery and control over his environment, the individual man finds himself dependent and powerless. If he is to do anything, even to survive, he must join with others, and often on terms which are not of his choosing, while in large-scale organizations (industrial and political) fewer men than ever have the opportunity of exercising initiative, making responsible decisions, and guiding and controlling much even of their own behaviour.

Prof. Macbeath did not deny the need for such large-scale organization or for the planning inherent in it; but they constitute, he urged, a main threat to freedom to-day. They tend to ignore the distinction between persons and things; and a main problem of our time is to guard against this inherent tendency to tyranny on the part of administrators. They are liable to identify the plan which they wish to impose with the good of the community; then all dissent is regarded as disloyalty, all criticism as unreasonable and all objectors as traitors. Not only is the only safeguard against major mistakes then gone, but, equally important, there is the danger of

inflexibility at a time when openmindedness and responsiveness to new ideas are more necessary than ever. Fixed ideas and habits to-day can be a public danger, and at best the time-lag between the technological changes and our habits and institutions causes a sense of tension and frustration in our society.

Such tension and frustration cause much unhappiness and division of loyalties in modern life. By undermining its cohesion, they encourage also the tendency to authoritarianism and the revolt against reason, and in such circumstances those who prefer ease to liberty are apt to be impatient and resentful of the dissenter or nonconformist who demands reasons.

It is in such circumstances that Prof. Macbeath champions the right to dissent and the vital function of the heretic. Toleration, he maintains, is to be encouraged, not as an indulgence to error, but as a method of arriving at truth and as a safeguard against mistakes. Failure in tolerance is indeed evidence of an ultimate lack of faith in the soundness of our beliefs, in the value of our way of life and in the intelligence of our people; it is evidence of fear that they cannot withstand criticism. The function of the heretic and critic is to force us to keep examining and testing, revising and perfecting our beliefs and ideals. When that function is no longer permitted, stagnation will set in and freedom and science and all they stand for will decay and die.

In the last analysis, points out Prof. Macbeath, there are only two ways of dealing with human beings—the way of persuasion and the way of force. Science stands for the former and can only flourish in an atmosphere of freedom, an atmosphere in which dissent and nonconformity and difference of opinion are tolerated. That freedom is one and indivisible: if it is threatened anywhere, it is everywhere in danger.

To science the chief danger is probably, as Prof. Macbeath suggests, not so much from positive restrictions consciously imposed, as that the atmosphere of a society which rewards conformity and penalizes dissent may cease to produce scientists, men imbued with the spirit of free inquiry. Nevertheless, those positive restrictions are serious enough and Prof. Macbeath's noble plea should rouse scientists everywhere to action against whatever restrictions cannot be thoroughly justified on impartial inquiry. His diagnosis shows clearly the real danger that science may be crushed by its own creations, and that scientists cannot afford to remain silent.

Prof. Macbeath, in this address, has very forcibly put the argument for freedom as one factor in national security, and he does not deny the necessity for striking a balance between individual freedom and national security. That issue, however, he does not discuss, and it is complicated by the further conflict of loyalties to which he scarcely refers—and then more by the implication that our concern should be to foster the loyalties which so much in our modern world tends to erode.

There can be no question that the defence of freedom has been made more difficult in the past few years by the question of loyalty, and in particular by the claims of some scientists to determine such issues entirely for themselves. Here Prof. Macbeath gave much less guidance than Prof. A. V. Hill in his presidential address, nor can it be said that the Present Question Conference on Conflicts of Loyalties? held at Oxford during August 2–9, so far as reported in *Question**, touches the vital issues. Mr. H. Westmann's address on "Conflicts of Loyalties?" and Prof. M. Polanyi's on "Science and Faith" present some of the features of Prof. Macbeath's diagnosis and of the danger of an anti-scientific attitude being engendered. While indicating the need for clear thinking, they give little clue as to how on one hand the roots of loyalty—whether to science, to society or to mankind—are to be re-established or how, on the other, confidence can be engendered in the society in which the scientist works so that his work will not endanger its security and welfare.

Where that confidence has been undermined, however, it has been at least in part because the scientist or technologist has first betrayed his loyalty to his own particular scientific discipline or professional tradition. That is primarily a matter for professional or scientific associations, and if they are neglectful the harm can scarcely be corrected from outside, while the attempt to do so endangers the whole condition of creative scientific activity. On such issues Prof. Macbeath's address is first and foremost a challenge to professional bodies of scientific men, and unless they meet the challenge with courage and imagination the danger to scientific advance to which he points may well become even more acute; without courage there is no liberty. Scientific men must safeguard the highest standards of professional conduct, integrity and loyalty; but they must also ensure that due place is found for the dissenters and nonconformists, whose vision and independence contribute so much to the flexibility of mind and receptivity towards new ideas necessary for the advance of science.

* *Question: a Journal.* Edited by H. Westmann. Vol. 5, No. 1: Conflicts of Loyalties? By Prof. M. Polanyi, J. H. Oldham, Prof. W. R. Niblett, H. Westmann and Herbert Read. (Published for the Present Question Conference, Ltd.). Pp. 112. (London: Hammond, Hammond and Co., Ltd., 1952.) 3*s.* 6*d.*

ECONOMICS OF THE PROTECTION OF PLANTS

Untaken Harvest

Man's Loss of Crops from Pest, Weed and Disease; an Introductory Study. By George Ordish. Pp. xii+171. (London: Constable and Co., Ltd., 1952.) 15*s.* net.

LOSSES caused by pests and diseases of plants have been expressed by many people in many ways. In this book, Mr. George Ordish maintains that such losses should not be calculated in terms of money or in terms of loss of yield but rather as a waste of land and labour. For example, if in the United Kingdom viruses are responsible for a loss of 10 per cent of the potato crop, the 7½ million ton yield represents only 90 per cent of the potential

yield and the real loss is not the difference between 7·5 and 8·3 million tons "but the land, the labour and the resources used to grow these ungathered tons". The question that immediately arises is whether this method of representing losses can be successfully defended on biological grounds? "Untaken Harvest" is a good selling title and rightly suggests some element of waste; but is it good biology or indeed good natural philosophy to regard as an 'untaken harvest' the land, labour and resources used for growing 'ungathered tons' that exist only in the imagination? Insects and fungi are part of the very complex community of living things; were they to be removed, what would be the result? Nobody knows, and nobody has yet grown an agricultural crop in the absence of insects and fungi. Though many biologists will not agree with Mr. Ordish's method of calculating losses, if they read this book they must agree that his case is very well argued and presented.

The book opens with a chapter on the pests and diseases themselves, in which there is also a brief résumé of control methods. Mr. Ordish then goes on to develop the main part of his thesis in Chapters 2 and 3; the losses caused by pests and diseases in many parts of the world are given, and their economic effects are described. The dangers and pitfalls awaiting the estimator of losses are discussed, and attention is directed to the lack of precise information and the need for more accurate figures and for better methods of assessing the losses. In spite of this, Mr. Ordish has in one table attempted to assess the losses by all the pests and all the diseases of all the crops in the United Kingdom. Let it be said at once that, *faute de mieux*, it is a brave attempt but lacking accurate figures; one is inclined to pause and say with Pope, "Tis with our judgements as our watches, none go just alike, yet each believes his own". Unfortunately, when once figures of this nature have appeared in print, they are apt to be quoted *ad nauseam*, and other useful and more reliable figures in this book may lie neglected and forgotten.

In Chapter 3, which deals with the economic effects of the losses, Mr. Ordish is thoroughly at home, and the book is worth reading for this chapter alone. In estimating the relative efficiency of control measures, a ratio is established between the cost of the control and the potential benefit derived; this is termed the cost/potential benefit ratio. The examples of such ratios given are worthy of careful study by the plant pathologist.

Chapter 4 deals with methods of combating the losses and the economics of the methods. These are well and fully discussed except that the credit for modern development in spray machinery appears to be very unevenly allocated. For example, no credit is assigned to the American forerunner of the autoblast type of machine, and no mention is made of the excellent work of the Long Ashton Research Station in this field. On this subject Mr. Ordish has dealt only with a fragment of the literature, and, if a new edition is called for, opportunity ought to be taken to restore the balance. In this chapter, too, he says: "It seems to be generally agreed among a large number of entomologists that treatment from the air is not as effective as from the ground". Though many entomologists may agree, more than a few will disagree, and further careful comparisons of the two methods are badly needed.

The social effects of the losses are discussed in Chapter 5, and considerations on present and future crop protection in Chapter 6, wherein the economics of the various methods of plant protection are also discussed. The book concludes with a chapter on the trade in insecticides, fungicides and related products, and there is an extremely useful table giving figures for world production and consumption of them.

Mr. Ordish, who is agricultural economist to Plant Protection, Ltd., has taken very great pains to read and collate an enormous amount of information which will be of great value to his colleagues in industry and to those who work in other spheres of applied biology. The emphasis could perhaps have been improved; but as an economist Mr. Ordish has been able to see the problem in perspective. As an economist, however, he seems to have missed an opportunity of bringing other important factors into the picture—cultivations, fertilizers, breeding for increased yields, climatic factors, etc. Although reference is made to the fact that wheat yields have, during the past hundred years, risen from 26 to 36 bushels per acre, it is not made clear that some of this increase is due to better varieties, some to seed treatment, some to mechanization, but most is undoubtedly due to the increased use of fertilizers. How do losses from pests and diseases fit into this picture? The answer to this question probably lies in closer co-operation between the soil chemist, nutrition chemist, plant pathologist, botanist, physiologist and all the rest of the scientific world that agriculture nowadays commands. I. Thomas

IDENTIFICATION OF COMMON WEEDS

Common Farm Weeds Illustrated

By Plant Protection, Ltd. Pp. vii+172. (London: Butterworths Scientific Publications, Ltd., 1952.) 15*s*. net.

FARMERS and gardeners must eradicate weeds, and in order to do so with the maximum of efficiency it is desirable that the weeds should be speedily identified, especially if the use of weed-killers is contemplated. But a weed is only a plant which is growing where it either is not wanted or is doing actual harm, so to the pure botanist it is just another member of the plant kingdom (unless it has invaded his own garden).

Any good book on plants (including weeds), therefore, is of value to farmer and gardener as well as to botanist; but the method of approach varies because the agriculturist and gardener seek to destroy, the botanist to study. So it is not surprising that the point of view also varies in that the farmer and the gardener fundamentally wish only to recognize the weed, no matter how, whereas the botanist treats the weed as a subject for scientific study. Perhaps, therefore, the botanist, especially the taxonomist, can be forgiven if he protests against the grouping of plants, no matter what they are, artificially according to colour of flower. This method is adopted here; but, in view of the book's objective, the method is justified since quick recognition is all-important.

The book is divided into two sections: (1) arable weeds; (2) grassland weeds. Following (1) is a list of grassland weeds also to be found on arable land; following (2) is a list of weeds common to both arable land and grassland. Two facing pages are devoted to each plant. On the left-hand page is a large photograph

of the plant in the juvenile stage; on the right, an adult plant is depicted. This is an ingenious method, for it will assist farmers and gardeners to catch their weeds in time. Below the two photographs are very simple descriptions using no technical terms. Here are described the plant itself, other popular names, general habit, shape of 'seed' and 'true' leaves, habitat, height, general appearance of flowers, habit of stems, and other points of recognition. Approximately eighty weeds are beautifully illustrated and well described.

The fact that the reviewer was able to go through the entire book in a matter of a few minutes, and, looking first at the right-hand pages, immediately recognized every adult plant, and, looking at the left-hand pages, recognized most of the juvenile plants, convinces him that the book will serve a very useful and important purpose for farmers and gardeners. Students of elementary botany will also find the book of considerable assistance in the identification of common plants.

L. J. F. Brimble

THE PLACE OF DANCING IN RELIGION

Religious Dances in the Christian Church and in Popular Medicine

By Prof. E. Louis Backman. Translated by E. Classen. Pp. xii+364. (London: George Allen and Unwin, Ltd., 1952.) 35*s*. net.

At all periods mankind has danced to get rid of surplus nervous emotion—to obtain release. During the First World War a United States hospital unit took over a British general hospital soon after the Germans had launched mustard-gas attacks. The sights and sounds were particularly distressing, and the nurses, new to war conditions, in many cases became hysterical, though doing their duties magnificently. When the matron organized dances, the nervous tension was released and the troubles ceased. It is only to be expected that, as dancing has this tension-relieving effect on a large number of people, it should appear in various forms in religious rites.

Even in prehistoric times it would seem that dancing had a place in the various cults. Both in ancient Egypt and in Greece dancers are shown in the pictures of religious festivals; again, we read in the Old Testament how David danced before the Lord. Many other examples could be given. Naturally, then, when Europe became Christian, dancing was absorbed into the new cultus, though the Church naturally looked on it with disfavour, and from time to time attempts to exclude it were made. Nevertheless, it was not only the populace who frequently expressed their religious emotions by dancing; the clergy and choir, too, sometimes danced during the services. The Easter dances before the high altar in the cathedral at Seville are well known and still take place, and many less famous though equally ancient ones still happen in churches or churchyards at certain times of the year in many parts of the world, including England. It is true that nowadays these old rites are tending to disappear, but that is owing to the dull uniformity which is being imposed on mankind by modern conditions.

Prof. E. L. Backman, of the Royal University of Uppsala, has brought together a wealth of information on this subject, and the resulting volume is of great interest. The Church authorities in England were on the whole very averse to dancing becoming part of the cultus, and England has perhaps fewer examples to show than is the case on the Continent. Nevertheless, during Queen Elizabeth's reign men and women danced to the music of pipes and drums both inside churches and in the churchyards. I rather feel, too, that Prof. Backman might have mentioned the queer ritual dance which takes place yearly at Abbots Bromley in Staffordshire, where the participants carry reindeer antlers in front of their faces. It is true the dance is in all probability older than Christianity; but it has been so much Christianized that the antlers are kept in the church in the charge of the parson. Altogether, the book makes very good reading, and the translation would seem to be excellent.

M. C. Burkitt

THE NEUROTIC IN SOCIETY

Social Psychiatry

A Study of Therapeutic Communities. By Dr. Maxwell Jones, and A. Baker, Dr. Thomas Freeman, Julius Merry, B. A. Pomryn, Dr. Joseph Sandler, Joy Tuxford. Pp. xix+186. (London: Tavistock Publications, Ltd., in collaboration with Routledge and Kegan Paul, Ltd., 1952.) 18*s*. net.

Neurotic maladjustment is so prevalent and individual psychotherapy so prolonged that the psychiatrist has always sought more rapid methods of cure. During the Second World War, for example, physical treatments were pushed forward and patients subjected to insulin, prolonged narcosis and electrical convulsions. The 'cures' by these means have proved disappointing. Now the accent is on social psychiatry. This is the production of a special environment where the patient can adjust and find ways by which he can later take his place in society.

Dr. Maxwell Jones and his associates have written this book describing experiences in such communities: at Mill Hill, where an effort syndrome unit was established, at Dartford ex-prisoner of war hospital, and at Belmont Hospital for chronic neurotic unemployed. In these it was found impossible, owing to the numbers, to give individual psychotherapy, and lectures were discovered to be less useful than discussion groups where the patients were able to release their emotion. "Psycho-dramas" which are little plays, describing his own life, written by a patient were also found beneficial. Inmates do a four-hour day in industrial work, and are placed in industry by a resettlement officer when they are discharged. The results are claimed to be good; and six months after leaving hospital two-thirds of the patients have made a fair adjustment, or better, and one-third a poor or very poor adjustment. This is an interesting experiment, but one should reserve judgment until follow-up results for a longer period are published.

It is a pity when they have such interesting material that the authors have used such a repetitious and even slovenly style: for example, on p. 178 the old mistake of thinking that 'protagonist' means the opposite of 'antagonist' is made. The book records valuable facts on community life, and one looks forward to the publication of the final results later on.

Clifford Allen

EXPERIMENTING AT HIGH PRESSURES*

By Prof. D. M. NEWITT, F.R.S., and K. E. BETT
Department of Chemical Engineering, Imperial College of Science and Technology, London

INVESTIGATIONS into the influence of pressure on the properties of matter are at present confined to limits prescribed by the mechanical properties of materials of construction. In plant designed to develop and sustain high internal pressures, two separate stress-systems have to be incorporated. The pressure is developed by an element of plant, usually a piston, in which there is under load an evenly distributed uniaxial compressive stress the magnitude of which is proportional to the pressure; and a portion of this element must be unsupported. Eventually the pressure has to be sustained by an enclosure, the walls of which are subjected to three principal stresses acting at right-angles to one another; two of these are tensile and one compressive. The important feature of this system is that the compressive stress and one of the tensile stresses are not uniformly distributed through the thickness of the walls, but have maximum values at the interior and diminish rapidly as the outer surface is approached.

A more uniform distribution of stresses under load can be achieved by making use of the property of work-hardening, as in the autofrettage process of cylinder construction; or by building a compound cylinder by the shrinkage process. In both cases it is necessary to know the distribution of the residual stresses and to develop means of stabilizing the residual system, so that no appreciable plastic flow will occur under working conditions. By making use of these processes and by providing external support for the vessel in such a way that the support increases proportionally to the internal pressure, it has been possible to construct plant in which pressures up to fifty thousand bars (a bar is approximately an atmosphere) can be maintained for considerable periods of time and pressures of the order of a hundred thousand bars for shorter periods. The energy stored in a material subjected to these stresses is made up of a work or potential energy component and a heat or kinetic component. Energy release may take place through either component separately or through a combination of the two, leading eventually to brittle fracture or plastic deformation.

It seems unlikely that these limits of pressure will be much exceeded with the materials and methods of construction at present available; and they are indeed sufficiently extensive to enable a comprehensive study to be made of those properties of matter which are associated with work done against the repulsive force fields of atoms and molecules.

There is, however, a second pressure domain of great interest to physicists, in which discontinuous transitions may be expected to take place by, for example, an overlap in the electron-phase space field of an atomic system. Calculations based upon quantum mechanical models place the lower limit of this domain at about one million bars; that is, far beyond any pressures at present attainable in the laboratory.

If attention is confined to the lower pressure domain, nearly every manifestation of pressure, whether chemical or physical, will require for its interpretation an accurate knowledge of at least three of the principal thermodynamic functions of the system, one of which, for obvious reasons, must be the pressure. A great deal of attention ought, therefore, to be paid to the accurate measurement of high pressure and to an assessment of the errors involved when the limits of practical working are approached.

Primary pressure gauges, of which the mercury column and the balanced free-piston gauge are examples, measure pressure in terms of fundamental units. They are, however, subject to restrictions imposed by the properties of the materials from which they are constructed and of the working fluid. Thus, in the case of the mercury column, the compressibility of mercury over the full range of the gauge has to be known; in the case of the free-piston gauge, the elastic and plastic deformation of the piston and cylinder assembly under the influence of pressure must be found, either by calculation or by direct measurement.

Suitably designed free-piston gauges will operate to about twelve thousand bars, but at this pressure they are relatively insensitive, due to the large frictional forces resulting from the increase in viscosity of the pressure-transmitting fluid. The area of the piston in such a gauge must of necessity be small, and direct measurement of the diameters of the piston and cylinder cannot be made with an accuracy sufficient to reduce the error of readings to less than 0·1 per cent. It is therefore necessary to obtain the effective piston area at low pressures by calibration against a mercury column or another free-piston gauge in which the diameter of the piston is large enough to be measured directly. At higher pressures, the piston and cylinder undergo deformation and the effective area, which is a function of pressure, has to be calculated from theories of elasticity. The error involved is uncertain, since the stresses arising from the efflux of liquid between the piston and cylinder cannot be measured directly.

In a free-piston gauge designed by P. W. Bridgman, the correction for elastic deformation was calculated to be $0{\cdot}2 \pm 0{\cdot}05$ per cent at 10,000 bars. Such a gauge will have an absolute accuracy of about 0·15 per cent, provided that its sensitivity is large compared with this figure.

A great deal of work at high pressures and, indeed, most of the work above ten thousand bars has been carried out with the aid of secondary gauges, of which the manganin gauge is the best known. Calibration of this gauge against a free-piston gauge shows that the response is a linear function of pressure to within the absolute accuracy of the primary gauge.

In order to extend the range of the manganin gauge to thirty thousand bars without the uncertainty of linear extrapolation, it is desirable to calibrate it against at least two fixed-pressure points. The lower point may be taken as the freezing pressure of mercury at 0° C., which is given by a free-piston gauge as 7,490 bars. The most suitable upper point is the I–II transition for pure bismuth, which at 30° C. takes place at 24,930 bars. This point has been measured directly by Bridgman using the

* Summary of three lectures given by Prof. D. M. Newitt at the Royal Institution on January 27 and February 3 and 10.

method of volume discontinuity. In his apparatus, the pressure was transmitted to a specimen of the pure metal in direct contact with the piston, the distortion of the cylinder containing the specimen being determined experimentally. From measurements of the force transmitted to the piston and the area over which the piston acted, the pressure could be calculated. It is difficult to estimate the accuracy of the pressure measurement; but the total frictional effect obtained by measuring the transition point for both increasing and decreasing pressure was about 6 per cent.

By using the fixed pressure points, the change in resistance with pressure of manganin wire can be expressed as an equation of the second degree. Although the departure from linearity depends upon the history of the wire, experience shows that, in general, the deviation is only about 2 per cent at 25,000 bars. The gauge can be made very sensitive to small pressure-changes when used in conjunction with suitable electrical measuring apparatus; but it will be obvious that its accuracy depends almost entirely upon the absolute accuracy with which the fixed pressure points are known.

At pressures much above thirty thousand bars, all available pressure-transmitting liquids either become very viscous or freeze, and the manganin gauge can no longer be used. Pressures in this range have, therefore, to be measured directly, it being assumed that, in a thin specimen of material under pressure, stresses sufficiently close to hydrostatic conditions can be realized. Corrections for distortion of the apparatus have to be computed; and, since the material is often stressed beyond its normal elastic limit, no great accuracy can be claimed for the result. At pressures of 100,000 bars, the error is probably of the order of $\pm$ 10 per cent.

Thus it can be seen that the error involved in the measurement of pressure is a function of the pressure-range under consideration. Below twelve thousand bars, it is possible to increase the precision of a free-piston gauge by reducing the distortion of the piston and cylinder assembly; this can be accomplished by using the stronger materials of construction now available and by providing more effective external support for the cylinder. It is doubtful if the range of the gauge can be greatly extended, because the large increase in viscosity of pressure-transmitting fluid results in a serious loss of sensitivity. At pressures above thirty thousand bars, when all liquids have frozen, true hydrostatic conditions no longer exist and stress differences within the compressed solid of the order of its plastic shearing stress are to be expected. In this range, the error in the pressure measurement resulting from the variable frictional forces opposing the motion of a piston is greater than that due to the uncertainty in the distortion of the cylinder. Thus, any attempt to increase the accuracy of the measurements must be directed towards reducing the frictional forces. One method of doing this is to decrease the cross-sectional area of the material under compression; such a procedure, however, makes the accurate assessment of volume changes during compression very difficult, especially if the apparatus undergoes appreciable creep.

Although Bridgman measured the freezing pressure of mercury more than forty years ago, no accurate redetermination has been made since then. Indeed, the value has been accepted and used to calibrate various primary and secondary gauges, some of which have a greater sensitivity than the accuracy claimed by Bridgman for his original measurements. In view of the difficulties involved in the direct measurement of pressure, it would therefore seem desirable for the present to base all work upon an arbitrary standard scale of fixed pressure points which can be corrected from time to time as more accurate data become available.

THE SOUTH ATLANTIC: LAND BRIDGES OR CONTINENTAL DRIFT?

THE proceedings of the symposium on "The Role of the South Atlantic Basin in Biogeography and Evolution", held by the Society for the Study of Evolution in New York during December 28–29, 1949, have now been handsomely published under the title of "The Problem of Land Connections across the South Atlantic, with Special Reference to the Mesozoic"*. Most of the contributions are remarkable—considering the speculative possibilities and heady enthusiasms inherent in the subject—for their scientific rigour, and several of them are of fundamental importance to everyone who is interested in the tangled complex of problems which come under discussion. These problems are essentially twofold: whether the southern continents received all their faunas and floras from the north or have been at times in direct contact with each other; and whether, if such contact existed, it was effected by land bridges or by contiguity, afterwards broken by continental drift. The chairman and editor, Dr. Ernst Mayr, points out that the symposium was organized, not to defend or disprove any particular hypothesis, but for the presentation and discussion of current evidence in one restricted but critical field of a much broader subject. In his conclusion he cheerfully admits that we are still confronted by many unsolved problems; but he claims with ample justification that the symposium has resulted in a much-needed correction of fact and clarification of concept. Dr. Mayr himself recalls the methodological principle that biological conclusions must be based on biological evidence, and geological conclusions on geological evidence. In particular, he directs the geologists' attention to the many pitfalls that lurk in biological interpretations—for example, in conclusions drawn from faulty classifications or from underestimates of the dispersal powers of organisms over long periods of geological time.

Dr. G. G. Simpson's illuminating discussion of "Probabilities of Dispersal in Geologic Time" (pp. 163–176) is one of the high points of this invaluable publication. Simpson deflates many a speculative balloon by stressing the impossibility of inferring two simultaneous conclusions from what is actually known of the geographical distribution of a given group of organisms—namely, the land connexions of the time, and the probabilities of dispersal for the organisms concerned. To obtain a solution for either unknown,

* Bulletin of the American Museum of Natural History, Vol. 99, Article 3: The Problem of Land Connections across the South Atlantic, with Special Reference to the Mesozoic. (Proceedings of the Symposium on "The Role of the South Atlantic Basin in Biogeography and Evolution", held at the Fourth Annual Meeting of the Society for the Study of Evolution, New York City, December 28 and 29, 1949.) By E. Mayr (editor), M. Ewing, W. H. Bucher, K. E. Caster, C. O. Dunbar, M. Kay, G. G. Simpson, D. I. Axelrod, T. Just, W. H. Camp, P. J. Darlington, jun., A. E. Emerson, B. Schaeffer, D. H. Dunkle, E. H. Colbert and A. S. Romer. Pp. 79–258+2 plates. (New York: Amer. Mus. Nat. Hist., 1952.) 3 dollars.

it is necessary to postulate either the existence (or absence) of land connexions or the probabilities of dispersal. Usually the latter postulate is made, the implication commonly being that p is either 0 or 1. Simpson illustrates the very serious errors that may arise from confusing 'very low' with 'zero' and points out that estimates of probabilities, even when least subjective, may be wholly invalidated by the effect of geological time. Just as probability of dispersal is affected by the size of the population, so the passage of time multiplies the opportunities for dispersal. "If the probability that some member of a population will cross a barrier is ·000001 in any one year . . ., during the course of a million years the event would be probable, $p = ·63$", and "in the course of 10 million years the event would become so extremely probable as to be, for most practical purposes, certain, $p = ·99995$". Simpson concludes that evidences of random dispersals at scattered times indicate that probabilities of dispersal were so exceedingly low as to suggest the intervention of a major barrier. Ten years ago Simpson[1] directed attention to the relevant fact that, of the known Triassic reptiles of South America, only 43 per cent of the families and 8 per cent of the genera are known in Africa, with no species in common. "These figures," he concluded, "are decidedly inconsistent with any direct union of corresponding parts of South America and Africa."

Among other general contributions, Dr. M. Ewing presents a useful summary (pp. 87–91) of geophysical evidence (up to 1950) and concludes that both seismic and gravity data show the great similarity of the Atlantic crustal structure to that of the Pacific, and their great dissimilarity to the continental crust. So far as such evidence goes, it is consistent with the hypothesis of the permanence of continents and ocean basins. But the Atlantic data are still too sparse to justify regional conclusions. Moreover, the discovery near the surface of crustal layers having the elastic properties of simatic rocks raises the question of what has happened to the many kilometres of sediment that must have accumulated over the original ocean floor, if the latter has existed for $\sim 3 \times 10^9$ years. Have they been deeply buried by repeated coverings of basic lavas and sills, and metamorphosed beyond seismic recognition? If so, their radioactive contents might account for the unexpectedly high heat flow encountered through recently tested parts of the ocean floor. If not, then the seismic evidence recorded by Ewing could be interpreted as against the 'permanence' and 'land bridge' hypotheses and in favour of 'drift'.

Prof. W. H. Bucher sets out to deal with the general problems of "Continental Drift versus Land Bridges" (pp. 93–103), but his treatment is largely confined to the thesis that the topography, depressions, mountain ranges and structural relations of the ocean floor cannot be harmonized with Wegener's assumption that the simatic crust is or has been so weak that sialic bodies could drift through it. The criteria are not strictly so decisive as Bucher claims, since he fails to consider fully the effects of metamorphism and altogether ignores the hypothesis of sub-crustal convection currents; nor does he even mention any of the evidence which favours the 'drift' hypothesis. Both Ewing and Bucher admit that vertical movements of considerable amplitude have demonstrably taken place, but Ewing limits the amplitude by the requirements of isostasy, while Bucher limits the area involved to that of a land bridge. Neither considers the possibility that the sub-crustal silicate mantle may not necessarily be as homogeneous in either space or time as theorists postulate. Localized changes of composition or phase, or of both, at depths below the so-called 'level of compensation' would adequately account for the vertical movements which seem so puzzling to geophysicists.

Turning to more specific evidence on South America and Africa, Prof. K. E. Caster gives an admirable and well-documented review (pp. 105–152) of the stratigraphical and palæontological data up to the end of the Mesozoic. Like others before him, he is so impressed by the Devonian–Triassic parallelism between the opposing lands that he favours a broad continental linkage up to the end of the Triassic. Nevertheless, he inadvertently raises a serious doubt as to the validity of what Dr. A. S. Romer (p. 253) calls "the strongest single piece of evidence for South American transatlantic connections". This is the occurrence of the supposedly freshwater reptile *Mesosaurus* in similar formations in South Africa and Brazil. Caster, however, records that *Mesosaurus* occurs in a fœtid limestone containing marine invertebrates, from which he infers that it was a nektonic animal inhabiting a seaway with a stagnant bottom. In a most stimulating discussion of Caster's paper, Prof. C. O. Dunbar makes the suggestion that, if *Mesosaurus* was thus adapted to a 'pelagic' life, it may well, like modern seals, have made long journeys to sea. In any event, it is improbable that migration could have been easy, since of the three African genera only one—and that of a different species—has been found in Brazil.

Another important point made by Dunbar is that, in the light of our present knowledge, the pre-Devonian record has no bearing whatsoever on the problem in hand. This is amply confirmed by recent work in dating the Pre-Cambrian. Caster states that the presence of *Collenia* "affords the best evidence to date for correlating strata in the oldest terranes on the two sides of the Atlantic basin". Unfortunately, the African occurrences to which he refers are in rocks which range in age from about six hundred million years to more than two thousand million years[2]. Dunbar also expresses the opinion that, until more is known about the reproduction of *Glossopteris* and its associates, it is scarcely necessary to drift continents or raise broad land-bridges to account for the distribution of this flora.

Prof. Marshall Kay also discusses stratigraphical evidence bearing on continental drift (pp. 159–162). His main point is to demonstrate from the distribution of Cambrian trilobites—on which weighty arguments have been based—that similarity of faunas does not in itself require close association later broken by 'drift'.

Dr. Mayr is satisfied (pp. 85 and 256) that there is no need to postulate former land connexions between South America and Africa to explain the distribution of mammals or birds, the available facts being "diametrically opposed to the possibility of such a connection". However, this clear-cut conclusion refers only to the late Mesozoic and Tertiary. For testing earlier connexions, fishes and reptiles are more suitable. Dr. E. H. Colbert reports fully on the Mesozoic reptiles (pp. 237–249). He thinks there may have been "a connection of sorts" during the mid-Triassic, but admits that no southern connexion would be essential if other evidence were forthcoming to prove that North and South America were then

connected. The Jurassic evidence is inconclusive, while for the Cretaceous it is "rather unequivocally in favour of an active faunal interchange between South and North America". Discussing Colbert's paper, Dr. A. S. Romer (pp. 250–254) agrees about the Cretaceous and Jurassic but, although fully conscious that most hypothetical land bridges are not merely delusions but also snares to the unwary, he mildly disagrees about the Triassic. He writes: "I find myself here, after consideration of the evidence [which he carefully analyses] rather strongly inclined towards belief in the existence of a southern intercontinental connection between South America and South Africa in the Triassic. To my embarrassment; for in such a 'leftish' position I am disturbed . . . by the company (of bridge builders, radical continent shifters and Gondwanaland collectivists) which this may entail". Dr. B. Schaeffer reports on the freshwater fishes (pp. 227–234), his conclusion—from what is admittedly a scanty record—being that there is no evidence of direct interchange between South America and Africa during any part of the Mesozoic.

In a most valuable paper on "Variables affecting the Probabilities of Dispersal in Geologic Time" (pp. 177–188), Prof. D. I. Axelrod illustrates his views with special reference to the effects of climatic and water barriers on angiosperm distribution. He claims that the continents have been in their present positions since the Middle Cretaceous and probably earlier: "The floras and the faunas, not the continents, have been moving during the past ages". Angiosperms, however, are not decisive for pre-Cretaceous times, and Dr. W. H. Camp's discussion of their phytophyletic patterns (pp. 205–212), though stimulating and suggestive, carries us no farther back. Dr. T. Just deals with the older and more critical fossil floras (pp. 189–204), but he finds the evidence insufficient for the drawing of firm conclusions.

In a brief survey (pp. 213–216) of living invertebrates in relation to Mesozoic South America, Dr. P. J. Darlington, jun., demolishes the idea that they provide any relevant evidence. In particular, he denies that paussids, which have been used as evidence of former land connexions, tell us anything significant about the history of South America. Prof. A. E. Emerson presents a highly original paper on "The Biogeography of Termites" (pp. 217–225) and reaches several tentative conclusions, the first being that "it is unnecessary to postulate any great change in continental masses and their connections since early Mesozoic times".

To end on a personal note: I should confess that, despite appearances to the contrary, I have never succeeded in freeing myself from a nagging prejudice against continental drift; in my geological bones, so to speak, I feel the hypothesis to be a fantastic one. But this is not science, and in reaction I have been deliberately careful not to ignore the very formidable body of evidence that has seemed to make continental drift an inescapable inference. In recent years the weight of evidence has become less oppressive, and this symposium has left me with the general impression that a few land bridges or linkages by island stepping-stones would probably suffice for the biogeographical problems. Matching of orogenic belts on opposing sides of the Atlantic is an exercise that has not been indulged in by the participants of this symposium. I have been collecting evidence from the Pre-Cambrian of South America, Africa[2] and India[4] for several years, and I think it is now safe to say that India cannot have been where Wegener placed it relative to Africa. The evidence on the other side, however, is still ambiguous. A remarkably good 'tectonic fit' between parts of South America and Africa can be recognized, but so far no correlation by age is possible, because the South American age determinations[5] have not been correlated with the tectonics and have not been checked by isotopic analyses. No doubt this temporary frustration will be overcome, and the matter will be decided one way or the other. At least we know how the problem can be settled.

Meanwhile, there remains the most serious enigma of all: the Permo-Carboniferous glaciations. Dunbar points out that the late Palæozoic glaciations in low latitudes present "a problem still unsolved, unless we accept continental drift". But if we accept continental drift only to explain these and other still older glaciations, it becomes no more than an *ad hoc* hypothesis. As such, it may still be justified as a stimulant to research, but it may also stand in the way of progress by distracting attention from the real problem. Can the meteorologists not come to our assistance and tell us whether or not widespread equatorial and low-latitude glaciation is possible while high latitudes for the most part enjoy a genial climate? The curious feature is that the evidence, so far as it goes, suggests that it was the distribution of ice in the Pleistocene that was exceptional, not the Permo-Carboniferous distribution. Southern Africa, in particular, was repeatedly glaciated during Pre-Cambrian times. While so many contradictory voices confuse judgment, one cannot do better than commend Dunbar's wise dictum that "it is unsafe to reject, *a priori*, either continental drift or foundering of broad land bridges".

ARTHUR HOLMES

[1] Simpson, G. G., *Amer. J. Sci.*, **241**, 1 (1943).

[2] Macgregor, A. M., *Trans. Geol. Soc. S. Africa*, **43**, 9 (1941). Ahrens, L. H., *Trans. Amer. Geophys. Union*, **33**, 193 (1952). Ahrens, L. H., and Macgregor, A. M., *Science*, **114**, 64 (1951).

[3] Holmes, A., *Amer. J. Sci.*, **248**, 90 (1950); Rep. 18th Int. Geol. Cong., London, Pt. 14, 258 (1951).

[4] Holmes, A., Leland, W. T., and Nier, A. O., *Amer. Min.*, **35**, 20 (1950).

[5] Marble, J. P., Rep. (1948–49) Com. Geol. Time, 72 (1949).

THE FARADAY SOCIETY, 1903–53

By DR. F. C. TOMPKINS

ON February 14, 1903, a small meeting took place in the rooms of the now defunct Faraday Club at St. Ermin's Hotel, Westminster, and a new scientific society was inaugurated. A little later "The Faraday Society" was formally founded, having as its objects the promotion of "Electrochemistry, Electrometallurgy, Chemical Physics, and Kindred Subjects". The Society celebrated its fiftieth anniversary this year on April 16 at the Royal Institution, which houses the famous laboratories where Faraday's researches were carried out.

In 1903, as to-day, there were dangers, both financial and otherwise, in creating yet one more society and one more journal. Indeed, Sir William Ramsay viewed the prospects with marked disfavour, for he could not find sufficient time to read the stream of scientific literature already appearing. Despite this, the project made a good start under the presidency of Sir Joseph Swan, ably supported by such eminent men as Prof. Crum Brown, Prof. F. G. Donnan, Lord Kelvin, Sir Oliver Lodge, Dr. Ludwig Mond, Lord Rayleigh, Sir James Swinburne and others. Within a year there were 254 members, with

F. S. Spiers as honorary secretary and editor of the *Transactions*. To these men we must attribute the coining of the phrase 'chemical physics' to describe the borderline field between chemistry and physics. It is no contradiction that in April 1951 the objects of the Society were re-defined as follows: "to promote the Study of Sciences lying between Chemistry, Physics and Biology", for the founders had wisely included that indefinite phrase "and Kindred Subjects". The Society could, therefore, adjust itself as a living organism to its environment. At its inception, the *Transactions* fulfilled the need of a publication catering for developments in the study of metals, both in the more academic and in its technical aspects, as well as one for reporting those studies recognized to-day as the province of physical chemistry.

The first volume of the *Transactions* appeared in 1905; in its 366 pages there are thirty papers, and the path along which the Society was to travel was, even then, clearly defined. The contributions were grouped, usually in pairs, covering different aspects of a common topic. The reading of the papers was followed by a discussion, and the importance of having a permanent record of the comments and criticisms of other scientists was appreciated. The earlier volumes of the *Transactions* contain such a record and it remains a constant source of historical interest and value. The second object which has been carefully nurtured through the subsequent years was the encouragement given to scientists from overseas to present papers; thus we find that, of the thirty papers in the first volume, one originated in the United States and another in France.

The Faraday Society, unlike many other scientific societies, has never held regular meetings devoted to the reading of papers on unrelated topics; rather it has sought to find a new approach to the technique of scientific discussion. The Society can point to the success of its endeavours by reference to its own General Discussions, the hundredth of which is being held in this, its jubilee year. The first, on "Osmotic Pressure", was held in January 1907 in London, and since that time two or more have been held yearly. The purpose of such Discussions was clearly defined—to secure a survey of the topic under discussion from the varied points of view of scientists working along different lines of attack; to focus general interest in a subject with the object of extending its development or applications; to afford an opportunity of bringing forward new facts and theories for criticism and appreciation; and finally to map out possible new lines of investigation. The Society is justly proud of its General Discussions, for even in this era of conferences they still retain a unique character. It had been accepted that the important aspect was critical appraisal of a large proportion of the papers, and practically the whole time of the meeting is therefore devoted to this. All the papers are published in full in the form of preprints two or three weeks before the meeting, so that they may be studied at leisure. A high standard of criticism is consequently attained, and the recognition of the value and quality of the verbal discussion has resulted in authors setting themselves a high standard for their contributions.

The success of these meetings and the achievement of their objects depends primarily on the choice of subject and the timing of the Discussion. In the main, faith has been placed in the national characteristic of compromise—the programme, though limited and well defined in scope, is so arranged that it is of value and interest to the physicist, chemist, biologist, geologist, etc.—that is, to scientists of different disciplines and experiences who bring different points of view to the common theme, and so effect a cross-fertilization of ideas, a synthesis and a stimulus to originality. Moreover, overseas contributions are particularly invited in order to obtain a representative cross-section of authoritative scientists, irrespective of nationality. The Society has, indeed, been fortunate in obtaining their constant support in its endeavour to make these meetings truly international in character.

Looking back, say, twenty-five years, to the time when the theory of strong electrolytes represented a new powerful approach to replace the classical theory of dissociation, we need only turn the pages of the 1921 Discussion volume to illustrate this point. Britain was represented by papers from Bell, Hartley, Wolfenden and Wynne-Jones, while from overseas came such distinguished men as Bjerrum, Brønsted, Fajans, Harned, Hückel, Onsager and Scatchard, and written contributions were received from Debye, McInnes and Randall. Scarcely a name which would spring naturally to one's mind when considering this topic is absent; and how aptly was the time selected. The Debye–Hückel theory appeared in 1923 and Onsager's extension three years later, but their work was still hotly debated. It is no exaggeration to attribute the general acceptance of these theories and the opening up of the modern attack on the problem of short-range forces in solution to this meeting. Again, two years later, in 1929, the overseas members and guests who attended and contributed to the Bristol meeting on "Spectra in Relation to Molecular Structure" included Raman of India, Badger, Birge, Mulliken, Taylor, Wood and others from the United States, Bonnino from Italy, Victor Henri from Switzerland, Grimm, Herzberg, Hund, Schaefer from Germany, Errera from Belgium, and representatives of the best work from Canada, France, Poland and the U.S.S.R.—a veritable galaxy of stars. The Society has done much for the consolidation of theory, the co-ordination of different lines of approach and the stimulus to further work, by timing these Discussions to coincide with the upward surge of interest and of development.

It is dangerous—and often invidious—to pin-point any one contribution as being that from which a marked advance in knowledge and development of the many varied aspects of physical chemistry has evolved. But one may sometimes reflect that, had not a contribution appeared at that particular time, then the road of advance would indeed have been more arduous and the progress along it slower. It is of interest, therefore, to browse through the pages of old Discussion numbers to find whether they record such papers of especial significance.

In 1921, on the subject of chemical kinetics, there was the first suggestion by Lindemann (now Lord Cherwell) of the modern concept of the nature of unimolecular reactions; this led to the well-known Hinshelwood–Lindemann theory and sounded the approaching doom of the old radiation theory. But, almost as if it were in compensation, after the destructive criticism of an application of radiation theory in one Discussion, there appears in a later one a concept of major importance in guiding the spectroscopist and the photochemist in a memorable contribution by J. Franck containing the first enunciation of that broad generalization, the Franck–Condon

Principle. Again, although the Society cannot claim to have published the original concept of chain reactions, its first application to hydrocarbon reactions is given in the 1926 Discussion volume, on "Photochemical Reactions", in a contribution by this year's president, Prof. H. S. Taylor, of Princeton. At another meeting seven years later, Rice proposed his chain mechanism of the thermal cracking of hydrocarbons. Although this concept has now been modified and extended, it is difficult to assess the immense value of this one contribution to many industrial developments. As is always true of any outstanding advance in fundamental theory, its value grows when quantitative deductions are made possible. The recognition of the guiding principle—that of the stationary state—is clearly stated in a paper by the outstanding German chemist, Bodenstein, in the 1931 Discussion. Two years later, Paneth described the synthesis of the antimony analogue of Bunsen's cacodyl radical at a meeting of the Society, and in the same year there were the enunciation of the Franck–Rabinowitch effect and the detailed applications by Hückel and Lennard-Jones of quantum mechanical theories and the birth of the modern language of molecular orbitals and the like.

In quite different fields, the Discussion volumes record equally significant and important discoveries, each of which has largely affected our modern outlook; thus in 1930 Donnan applied to organisms his ionic membrane equilibria; a 1932 Discussion reports H. S. Taylor's concept of activated adsorption and the theoretical contributions of Lennard-Jones on the application of potential energy relationships to adsorption—and there are many more.

Although its publications contain the record of many such important advances in particular branches, yet the Society has never attempted to contract its wide field of interest. The whole of the region lying between physics, chemistry and biology is deemed its province, so that the range covered is possibly unsurpassed in scope and breadth in any similar series of publications. At first there was a bias towards the more technical and applied aspects, with Discussions on fluxes, slags, igneous rock formation, soils, refractories, cements, corrosion, electroplating, passivity and hardening of metals, to list only a few. The later publications are concerned with the more fundamental problems as exemplified by meetings devoted to kinetics, photochemistry, radiation chemistry, electrode processes, spectroscopy, molecular structure, adsorption, chromatography, solid reactions, dielectrics, luminescence, crystal growth, etc. In addition, the growth of colloid science has always been one of especial concern to the Faraday Society. More than any other single body it has been responsible for the development of, and interest in, this subject in Great Britain. Inspired by the enthusiasm of Sir William Hardy, this interest has been constantly maintained, particularly by the efforts of Sir Eric Rideal.

In 1934, the Colloid Committee of the Faraday Society was formed. Broadly conceived, with representation from other interested societies, it received generous help and guidance from the Council of the Society, and one General Discussion every two years was devoted to a subject of interest to colloid chemists. Using the organizing facilities of the Society and with its financial backing, the Colloid Committee went forward, and it is possible to trace the emergence and growth of colloid science in the publications of the Society. Again an initial trend towards aspects having technical value gave place to more fundamental problems; for Discussions on soils, textile materials and the like were followed by others on colloidal electrolytes, the electrical double layer, and the size and shape factor in colloidal systems. More recently, the Society has again taken a lead, this time in fostering the growing interest in biophysics. So long ago as 1930, a Discussion was held on "Colloid Science applied to Biology"; "The Properties and Functions of Membranes, Natural and Artificial" was one of the topics in 1937, and "Modes of Drug Action" in 1943. A pattern was slowly emerging and was thrown into relief in 1948 when the Society, always responsive to modern developments, decided to enlarge the scope and activity of the original Committee by reconstituting it as the Colloid and Biophysics Committee of the Faraday Society, and also to devote one Discussion yearly to topics of interest to that Committee. Such Discussions held over the past few years include "The Physical Chemistry of Proteins", "Lipo-proteins" and "The Optical Methods of Investigating Cell Structure". The Committee also initiates informal meetings on similar subjects of importance to biophysicists and colloid scientists, summaries of which are published in the *Transactions*.

Nevertheless, although the aims and objects of the Society can be well appreciated by a study of its Discussions volumes, the *Transactions* published monthly contribute no less vigorously to the life of the Society. It has been termed the foremost journal in Europe devoted solely to physical chemistry. Although only a hundred and fifty or so papers appear yearly, the lack of size is in part a measure of the high standard required of the contributions.

If the international character of the Discussion meetings is emphasized by the fact that 50 per cent of the papers may be contributed from overseas and that, of the audience of two to three hundred, eighty–ninety are resident outside Great Britain, then, although contributions to the *Transactions* are predominantly from the United Kingdom, yet some six hundred members out of the total of more than 2,200 are from outside the British Isles—some from the Dominions and Colonies, others from all the countries of Western, and some from Eastern, Europe, and many from the United States and the South American continent. On its fiftieth birthday, it is appropriate, therefore, that the president should be Dean H. S. Taylor, who for the past twenty years or more has done so much to enhance the reputation of Princeton University as one of the foremost schools of physical chemistry.

The Society has seen many changes: the original objects with their bias towards electrochemistry, metallography and metallurgy in its more technical aspects have changed, but its efforts in this field have not been unrewarded, because this interest has been taken over by what may be affectionately termed its daughter society, the Institute of Metal Finishing, formerly the Electrodepositors' Technical Society. There is no doubt that other similar changes and broadening of interests will be initiated in the future; perhaps the formation of further daughter societies encouraged by the expanding interests of science may be anticipated.

The Faraday Society has been well served by its members. Because of its generous benefactors, particularly Colonel J. J. Bourke, its financial problems, although not absent, are often less serious than are those of many other scientific bodies, and

because of the enthusiasm of its first secretary, F. S. Spiers, whose name is perpetuated by the Spiers Memorial Lectures (the seventh of which will be delivered this year by Prof. J. H. Hildebrand), and of his successor, G. S. W. Marlow, the Society has never lost its initial impetus.

Its purpose remains to serve the changing needs of those interested in the sciences lying between chemistry, physics and biology, and to foster the international co-operation of scientists. Inspired by this purpose, a General Discussion on "The Reactivity of Free Radicals" was held last year in Canada at the University of Toronto. It proved a stimulating innovation; forty-five members travelled from Great Britain to meet in conference some eighty Canadians and sixty Americans. Those members will long remember their enthusiastic welcome in that great Dominion; they returned richer in knowledge and experience, with an increased appreciation of the high quality of the scientific contribution which Canada is making. The future may see this as the first of many Faraday Discussions to be held in other parts of the Commonwealth, the United States and Western Europe. The Society may hope thereby to contribute still further to "the glory of holding aloft among the nations the scientific name of England", to quote the words of Tyndall in appraising the genius of the man whose name the Society has been proud to assume.

OBITUARIES

Prof. J. W. McBain, F.R.S.

On March 12, one of the great pioneers in the field of what is now termed 'colloid science' passed away. The era of regarding colloids as an interesting field for those who desired to prepare chemical substances in curious and unexpected states was just beginning to pass when, as Leverhulme professor at the University of Bristol, James W. McBain commenced what proved to be his main interest in subsequent years at Leland Stanford University, California, namely, a systematic investigation of the properties of soaps and their solutions. We are indebted to McBain not only for the elucidation of the complex series of phases which these systems can exhibit but also for the concept of the 'micelle', both neutral and ionic, which had the most profound influence on subsequent developments in the fields of colloidal electrolytes. While the actual shape of the micelle in any particular system is still a matter of controversy, we may note that McBain recognized two distinct forms, the spherical and the lamellar. Indeed, he postulated the existence of the latter form, re-discovered in 1947, as early as 1925.

The contributions of the McBain school to the thermodynamic properties and physico-chemical behaviour of these molecularly associated colloidal electrolytes would alone justify the inclusion of his name among the fathers of the science.

McBain's researches in molecular association were not confined to aqueous systems. Apart from detailed studies on gels and jellies in non-aqueous systems, a great deal of pioneer work on what is now termed 'solubilization', for example, of water-insoluble dyes and hydrocarbons by means of soaps, has come from his laboratory; and we are indebted to him for an understanding of the factors operative in what he termed 'co-solvency', which is of great importance in blending.

McBain was one of the first to recognize that the uptake of a gas by a porous solid might involve quite a number of distinct and separate processes taking place simultaneously, and, to cover them all, introduced the term 'sorption'.

On the technical side we are indebted to McBain for many interesting and valuable research methods, such as the McBain sorption spring balance, the McBain air-driven centrifuge, as well as his ingenious methods of skimming off the Gibbs layer in a Langmuir trough, and evaluation of the osmotic coefficient by observations on the depression of the dew point.

McBain's contributions to colloid science consist not only in numerous papers to scientific journals; a number of valuable text-books have also emanated from his pen. These books are distinguished for their clarity of exposition, their style and their broadness in outlook on the topics under discussion. His last book, published in 1950, is designed to give the author's concept of the domain of colloid science. It is interesting to note that he does not limit the field to the properties of interfaces, but considers organization and form as equally important.

On retirement from Leland Stanford, McBain spent five years as director of the National Chemical Laboratory in India, a period which he completed only last year.

McBain had many friends, and he kept them. His character is most clearly revealed by his answer to the query put to him by the writer as to what impelled him to accept Pandit Nehru's offer of the Indian appointment. He replied that he was so impressed by the signs of starvation and low economy of many of the Indians that he thought it necessary for him to try to do something about it, and he believed that the infiltration of science and scientific methods was the only way by which anything radical could be accomplished.

Eric K. Rideal

Father A. Gatterer, S.J.

Father Alois Gatterer, *S.J.*, who died on February 17, was a natural scientist of the best nineteenth-century tradition, student and teacher by turns throughout his career. Born of Austrian stock in 1886, he was educated in Carinthia and there entered the Society of Jesus at the age of nineteen to continue his studies in rhetoric, philosophy and theology. He was ordained as priest in 1915 and joined the staff of the faculty of theology in the University of Innsbruck; there he also studied chemistry and physics, graduated and was appointed to the staff. He was released from lecturing in philosophy in order to pursue his scientific studies. At the age of about forty he studied physics for a year at Oxford and developed an interest in spectroscopy, which he pursued on his return to Innsbruck.

In 1930, when he was forty-four, he was invited to join the staff of the Observatory at the Vatican, where he established and developed a spectroscopic laboratory, largely with the aim of analysing a valuable collection of meteorites bequeathed to the Observatory by a French mineralogist. This laboratory has gradually become excellently equipped, with the aid of grants from Pius XI and his successor.

One of Father Gatterer's first tasks was to purify carbon rods for electrodes: a new method of doing this was developed, and then early tests on meteorites showed up the weakness of the atlases of spectra then available. During 1937–49 one of the main tasks of his laboratory was the preparation of

photographic atlases of the arc and spark spectra of iron, and then of the most useful lines of the remaining elements—a task which demonstrated Gatterer's endless patience and devotion to precision. These atlases are valued all over the world, and the last of them is one of the few subjects about which there is ever direct communication between Moscow and the Vatican.

In order to obtain pure iron for these reference spectra, pioneer work was done on the purification of iron; the method was eventually applied in an Austrian industrial laboratory in 1938. Another analytical problem which Father Gatterer helped to solve was the spectroscopic estimation of the halogens and of sulphur by the use of high-frequency discharges in vacuum to excite the spectrum. In 1938 Gatterer took the initiative in founding the international journal called *Spectrochimica Acta*, which was published in Germany by Springer, and which continued to appear with the names of its foreign editors on the cover until 1944. In 1947 Gatterer revived the journal and it was published from the Vatican Observatory for two years, after which it was returned to commercial production. Under Gatterer's editorship the printing received the same attention to detail as a spectrum gets.

Father Gatterer was a member of the Joint Commission on Spectroscopy of the International Astronomical Union and the International Union of Pure and Applied Physics; and he was delighted when that Commission and the International Astronomical Union both met in Rome last year, so that many of his friends could visit his laboratory.

Not only natural scientists but also industrial spectroscopists owe much to their contacts with Gatterer, who was an honorary member of national organizations of spectroscopists in both Italy and France. Manufacturers of spectrographs in both hemispheres benefited when he visited them to order apparatus to his own exacting specifications. From the age of twenty-six onwards he suffered from a series of painful illnesses, and he was partly crippled during most of these years. His cheerful fortitude under physical burdens and the humility underlying his devotion to truth made him an inspiring friend and teacher.

E. VAN SOMEREN

Prof. P. Niggli

PROF. PAUL NIGGLI, who died recently in Zurich after only a few hours illness, was born on June 26, 1888. He had been director of the Mineralogical and Petrographical Institute of the Eidgenössische Technische Hochschule since 1920; and he had been also rector of the Highschool during 1929–32, and of the University of Zurich during 1940–42.

Paul Niggli graduated at the Eidgenössische Technische Hochschule in 1907 as an engineer, but he chose to make mineralogy his special subject and studied for a short time at Karlsruhe and later at the Geophysical Laboratory of the Carnegie Institution at Washington and published several papers with G. W. Morey. In 1914 he returned to Zurich, but later in the year he accepted a professorship in mineralogy and petrography at Leipzig and went to Tübingen in a similar capacity in 1918. On Grubenmann's retirement, Niggli was called to succeed him as professor at Zurich in 1920, and there then began the building up of an institute renowned for the high standard of its teaching and research. He was assisted there by a devoted team of able professors and assistants. Germany made one attempt to lure him back to take the chair of mineralogy and petrography at Charlottenburg, but Niggli decided to remain at Zurich, to the great delight of staff and students, who celebrated the occasion by a torchlight procession in his honour.

Niggli was a man of great ability, wide knowledge, and immense industry. His masters at Zurich were Albert Heim and Grubenmann, and his earliest published works as a student were on the chloritoid schists of the Gotthard massif and a geological map of Zofingen, his own birthplace. A list of his very numerous books and papers was published in the "Festschrift" issued in honour of his sixtieth birthday in 1948. He ranged over the whole field of crystallography, mineralogy and petrography, and sought especially to expound the principles of physical chemistry that apply to the paragenesis of minerals and the differentiation processes and metamorphism of rocks. In his "Geometrische Kristallographie des Diskontinuums" (Leipzig, 1918–19), he brought up to date Schoenflies's "Krystallsysteme und Krystallstruktur" (1891), introducing the new work based on X-ray analysis. This was followed by many papers and chapters in his "Lehrbuch", and others on crystal structure and stereochemistry. He was an editor of the *Zeitschrift für Kristallographie* during 1920–40.

His "Lehrbuch" (Berlin, 1920) ran to three editions; but each 'edition' was really a different book presenting various parts of the subject of crystallography and mineralogy from new angles and in the light of new knowledge. Unfortunately, Part 3 of the third edition, written in 1944 and set up in type, was twice destroyed in Berlin during the War, and Niggli had not the heart to write it again.

Petrology and the working out of methods of handling and studying the mass of chemical data available on igneous and metamorphic rocks, and the application of physical chemical principles and phase rule to the problems, figured largely in his work at Zurich. He collaborated with Grubenmann in a new book on metamorphism (1924) and with Burri in a vast survey of the mineral-chemical characters of the younger eruptive rocks of the Mediterranean orogeny, covering, in fact, a region stretching from America eastwards to the western shores of the Pacific. This work, in which more than two thousand chemical analyses were handled, used to the full Niggli's method of recalculating analyses in 'Niggli values', a method which, together with his later system of molecular norms and his graphical methods for comparing and exhibiting chemical characters of rocks, have all had considerable influence on petrography throughout the world.

Niggli was somewhat reserved in manner, especially in later years. Much of his writing was in rather difficult German, and he rarely wrote in English although he spoke it fluently. His great ability received world-wide recognition. He received honorary doctorates from the Universities of Stuttgart, Budapest, Liège and Sofia; he was given the Hayden Award of the Philadelphia Academy of Natural Science, the Roebling Medal of the Mineralogical Society of America, and the Orville Derby Medal (Rio de Janeiro), 1952. As a corresponding or honorary member he had been elected to no less than twenty-seven academies and societies, including the Geological Society of London and the Mineralogical Society, of which he was the senior honorary member, having been elected in 1933.

W. CAMPBELL SMITH

NEWS and VIEWS

National Physical Laboratory Standards of Radioactive Isotopes

Dr. E. C. Bullard, director of the National Physical Laboratory, has issued the following announcement: "The National Physical Laboratory has at present the main responsibility for standards of certain radioactive isotopes in Great Britain. It is proposing to issue standards of these isotopes at regular intervals to meet the needs of those whose use of such materials justifies absolute standards and to supplement the normal calibrations which can be obtained on request from the Atomic Energy Research Establishment, Harwell. Standards of iodine-131, based on the British Standard (see *Nature*, **170**, 916; 1952) for this isotope, will be issued on or about October 15, 1953. Future issues will take place twice-yearly in mid-April and mid-October. The iodine-131 standards will be in the form of sealed ampoules of solution. Two different levels of activity will be available, one of 1 millicurie in 1 ml. of solution and one of 100 microcuries in 4 ml. of solution. Issues of standards of phosphorus-32 (100 microcuries in 4 ml. of solution) are planned to take place on June 15 and December 1, 1953. Applications for these standards should reach the National Physical Laboratory not later than a fortnight before the appropriate date of issue, and should include a statement of the purposes for which the standards are required. A fee of £10 will be charged for each 1-millicurie standard and of £5 for each 100-microcurie standard. It is requested that applicants should make their own arrangements for the collection of their standards from the Laboratory. An announcement relating to the issue of cobalt-60 standards will be made in the near future."

Research in Coal Mining: Dr. L. C. Tyte

The National Coal Board has appointed Dr. L. C. Tyte to be director of its second Central Research Establishment at Isleworth, Middlesex, which is engaged on investigations of the underground problems of the industry. Dr. Tyte will be responsible to the Director-General of Research, Dr. W. Idris Jones, at headquarters. Dr. Tyte, who is forty-six, was educated at Queen Mary College, University of London, where he carried out research under Prof. C. H. Lees. Later he joined the Government Scientific Service at the Research Department at Woolwich Arsenal and latterly has been engaged on projectile research. He was promoted deputy chief scientific officer in 1950 and was technical director under Sir William Penney at the Monte Bello trial.

Wigan and District Mining and Technical College

The Wigan and District Mining and Technical College, now in its ninety-sixth session, celebrated Founders' Day for the first time for fifteen years on March 25, when Sir Hubert Houldsworth, chairman of the National Coal Board, was the chief speaker. Sir Hubert, who paid tribute to the work of the College in providing leaders in many industries, referred to the scholarship scheme of the National Coal Board. Although Great Britain is suffering, among other things, from an insufficiency of qualified technical men, the Board is unable to find sufficient candidates for its hundred scholarships each year, although those selected have done well. Sir Hubert referred in particular to the desirability of more applications from those leaving school with a leaning towards physics, chemistry, mathematics and geology. Although many of the key positions in the industry are filled to-day by those who had no previous connexion with mining, he believes that a restricted mentality towards mining in schools outside the mining areas may be hindering recruitment. Emphasizing the need for attracting more men and the opportunity for those who have had their scientific—and preliminary—training at such a college or at a university, Sir Hubert welcomed the contribution of the Wigan Mining College to training for leadership for other industries. More than technical skill is required if the efficiency of the mining industry, or others, is to be raised and the lag between discovery or invention and application to practical purposes reduced. Besides technical knowledge, integrity, boldness in conception and soundness in judgment, leadership in industry demands interest in and understanding of human beings. Sir Hubert also stressed the importance of watching for originality and seeing that it is given full scope, particularly in research, and concluded by stressing the need for inculcating a spirit of service to the whole community.

In his report as principal, Dr. E. C. Smith said that, since Founders' Day was last celebrated, the number of students has increased from about 1,800 to some 3,000. Evening students have tended to decrease in numbers; but those attending on part-time day release have increased continuously from 220 in 1938 to 1,200. Such co-operation is specially marked with the National Coal Board. Full-time students have increased from 155 to more than 400. Dr. Smith referred to the extent to which the College has supplied training in technical teaching and administration to those who have since become heads of technical colleges or departments elsewhere, and stated that more officials of the National Coal Board have been trained at Wigan than at any other technical college or university in the country. The College library provides a first-rate service not only for the staff and students of the College, but also for research workers within the field covered, and the Manchester Geological and Mining Society now has its headquarters at the College.

Technical Resources of Industrial Firms

In reply to a question in the House of Commons on March 31, Mr. A. H. E. Molson, Parliamentary Secretary to the Ministry of Works, representing the Lord President of the Council, stated that the Manchester Joint Research Council's survey of the technical resources of industrial firms is complete, and that the Council is preparing a report for possible publication. The Department of Engineering Production in the University of Birmingham is continuing its survey under a research contract with the Department of Scientific and Industrial Research. A pilot survey of the technical resources of industrial firms in two small selected areas has been carried out by the Social Survey; but it is not proposed to publish a report of this survey. Mr. Molson added that the Department of Scientific and Industrial Research is considering the preparation of a general paper covering all three surveys.

Scientific Instruments of George III

A collection of more than three hundred and fifty scientific instruments and pieces of apparatus was made for the instruction of George III (1738–1820), when a youth, and was afterwards used for the

education of his children. From 1769 onwards, these instruments were housed at the King's private observatory at Richmond, Surrey, a building now known as Kew Observatory. In 1841 they were presented to King's College, London, where they remained until they were transferred on loan to the Science Museum, London, S.W.7, in 1926. The collection has been on view to the public on only two previous occasions, namely, for short periods in 1928 and 1949, and the recent completion of the first stage of the rebuilding plan for the Science Museum now makes it possible for approximately one-half of this collection to be placed on permanent exhibition in one of the reconstructed galleries. The instruments, the majority of which were acquired between 1740 and 1768, cover the field of study known, in the eighteenth century, by the title of 'experimental philosophy'; although the collection is particularly rich in material designed for experiments in mechanics, pneumatics and electricity, numerous examples are also included of instruments used in astronomy, optics, surveying, magnetism, acoustics, chemistry and heat. The collection thus affords not only a valuable display of the type of science being taught during an important era in scientific development, but it also provides a fine example of the skill and craftsmanship of the scientific instrument maker of the period. A descriptive catalogue of the complete collection is now available from the Science Museum (price 7*s.* 6*d.*), and there is also a guide book (price 6*d.*) which gives a brief outline of the history of the collection, together with notes about some of the more important scientific instruments represented in the exhibition.

Bibliography of Geiger–Müller Counters

A SHORT but useful bibliography of articles that have appeared during 1931–50, inclusive, on Geiger–Müller photon counters has been compiled by J. E. Walker, of the Electronics Division of the United States National Bureau of Standards (Report 1050; pp. 16; Washington, D.C.: Nat. Bur. Stand., 1952). Eighty-one papers or books, arranged in alphabetical order of authors, are listed. Most of the papers in English and German have been included, but only a selection of those in French, Russian and Italian; and it is a pity that no attempt was made to make the bibliography complete. Each reference is followed by either the author's abstract or comments by Mr. Walker. Those of historical interest only are dealt with very briefly.

Oil Exhibition at the City Museum, Bristol

A SCIENTIFIC and technical oil exhibition, designed expressly for a museum public, is now on view in the City Museum, Bristol, until May 2, prior to touring other provincial museums. Developed by the Shell Petroleum Co., Ltd., the exhibition aims both at attracting and educating, and is readily understandable without the need for accompanying lectures or explanatory talks. Starting with the origin of oil, the exhibition goes on to deal with exploration, drilling and the development of oil fields and with the different means of transport; the chain of events from refining, manufacture and research to the distribution of products to consumers is also outlined. The whole arrangement is made up of twenty-two portable display cases, one or more of which are devoted to each of the fifteen subjects into which the activities of the industry have been divided. The treatment of the displays differs: some include models, reliefs or dioramas; others are purely photographic, with pictures of artistic merit as well as of technical interest. Each display is labelled, and there is a descriptive leaflet available to visitors.

Flora and Fauna of South Carolina

THE first number of *University of South Carolina Publications: Series* 3, *Biology*, has recently been published (1, No. 1; pp. 41; 1952; from the University, Columbia, S.C.; 75 cents). This is a new journal that is to be devoted to taxonomic studies of the flora and fauna of the State of South Carolina. It is published by the Research Committee of the University at irregular intervals as the material is available, and the first number consists of two contributions, the first of which, by J. T. Penny, is on the amphibians and reptiles of the State. Of the amphibians, fifty-five species with eleven sub-species are listed and, of the reptiles, fifty-nine species and fifteen sub-species, which gives an idea of the richness of this fauna in South Carolina. In each instance the type locality of the form is given. The second paper, by Harry W. Freeman, on the "Fishes of Richland County", is based upon a collection from thirty-seven localities, all listed, and reports forty-nine species and one specimen considered as a hybrid. Up to the time of this collection only eighteen species had been recorded, and the author obtained thirteen of these, so that the total number of species recorded from the county is fifty-four. Both papers start with a short historical introduction, a point to be commended; the first reptile to be recorded was the alligator in 1682, but the first serious beginning was Catesby's classical "Natural History of Carolina, Florida and Bahama Islands" (1730–48). Both papers also conclude with a complete bibliography. The printing, paper and layout are very satisfactory.

First International Polarographic Congress, Prague

THE third volume of the proceedings of the First International Polarographic Congress, held in Prague during February 1951, has now been published (pp. 774; from Orbis-Export, 30 Ve Smeckach, Prague II; 10.80 dollars). The volume contains eight reports on the field of modern polarography, including its applications in chemical analysis, biochemistry and medicine, and these are followed by fifty-six contributions to the Congress, with discussions. The text is in Czech, with versions in Russian and extensively in English and German. This adds considerably to the bulk of the volume, but will be appreciated by readers not familiar with the first two languages. The volume is impressive as showing the great advances made in the important subject of polarography, and should be found of considerable interest.

Second International Congress on Rheology, Oxford

THE detailed programme of the Second International Congress on Rheology (see *Nature*, **170**, 487; 1952), to be held in Oxford during July 26–31, has now been published. The address by the president of the Congress, Sir Geoffrey Taylor, will be on "Rheology for Mathematicians", and other general lectures will be given as follows: on the electroviscous effect (in French), by Mme. A. Dobry Duclaux (Paris); rheological problems in the fabrication of plastics, by R. S. Spencer (Midland, Mich.); rheology and applied mechanics, by R. N. J. Saal (Amsterdam); rheological behaviour and the molecular jumping mechanism, by F. H. Müller (Marburg); water association and hydrogels, by E. Forslind (Stock-

holm); and biological problems for the rheologist, by P. Eggleton (Edinburgh). The other papers in the programme will be read at one of the three sections of the Congress; it is noteworthy that a number of the authors of these papers come from countries other than Great Britain, namely, Brazil, France, Germany, Holland, Sweden, United States and Yugoslavia. The Congress fee is £4, which includes preprints of all the papers to be read; orders for additional copies of the proceedings and for off-print copies of individual papers should be addressed to the publishers, Butterworths Publications, Ltd., 436 Strand, London, W.C.2. Application forms for the Congress (to be returned by May 1) and further details can be obtained from the honorary organizing secretary, Dr. G. W. Scott-Blair, University of Reading.

Oxidation of Oils and Fats: Symposium in Cambridge

A symposium on the oxidation of oils and fats will be held by the Oils and Fats Group of the Society of Chemical Industry on April 24 at the Low Temperature Research Station, Downing Street, Cambridge. Prof. C. E. H. Bawn will give an introductory address, and he will be followed by talks on recent research, as follows: Dr. C. H. Lea, on oxidative deterioration of lipids; Dr. A. Banks, on autoxidation of linoleic acid; Dr. L. A. O'Neill, on autoxidation of drying oils; and Dr. J. H. Skellon, on oxidation of monoethenoid fatty acids and esters. Further information can be obtained from the General Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

Chemical Society: Officers

Officers of the Chemical Society have been elected as follows: *President*, Prof. C. K. Ingold; *Vice-Presidents*, Prof. F. G. Donnan, Sir Ian Heilbron, Sir Cyril Hinshelwood, Dr. W. H. Mills, Sir Eric Rideal, Sir Robert Robinson, Prof. G. R. Clemo, Prof. R. D. Haworth, Prof. D. H. Hey, Prof. E. L. Hirst, Sir John Simonsen and Prof. M. Stacey; *Treasurer*, Sir Wallace Akers; *Secretaries*, Prof. H. Burton, Prof. E. D. Hughes and Dr. L. E. Sutton; *New Members of Council*, Prof. F. Bergel, Prof. M. J. S. Dewar, Dr. I. J. Faulkner, Prof. Brynmor Jones and Dr. A. I. Vogel.

Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: D. F. Phillips (agricultural assistant, Tanganyika), agricultural officer, Tanganyika; F. A. Rabagliati (assistant agricultural officer, Kenya), agricultural officer, Kenya; B. J. Silk (agricultural education officer, Gold Coast), senior agricultural education officer, Gold Coast; F. Durocher-Yvon (director of agriculture, Seychelles), agricultural officer, Northern Rhodesia; S. J. Curry (entomologist, Cyprus), entomologist, Kenya; Major the Hon. P. L. A. O'Brien (geologist, Northern Rhodesia), senior geologist, Northern Rhodesia; Gunn Lay Teik (chemist, Agricultural Department, Federation of Malaya), senior chemist, Agricultural Department, Federation of Malaya; D. F. Laing and F. E. Trevitt, veterinary officers, Nigeria; B. McCulloch, veterinary research officer, Tanganyika; R. Blower, soil conservation officer, Kenya; C. Bos, arrowroot processing chemist, Windward Islands; T. D. Rees, geochemist, Geological Survey Department, Tanganyika.

Announcements

The Royal Astronomical Society has elected Prof. V. A. Ambartsumian, of the University Observatory, Leningrad, and Prof. A. Unsöld, of the University Observatory, Kiel, to be associates.

Dr. Detlev W. Bronk, president of the Johns Hopkins University and president of the United States National Academy of Sciences, has been elected by the Paris Academy of Sciences to be a *correspondant* for the Divisions of Free Academicians and of the Application of Science to Industry in succession to the late Prof. F. Marguet.

Mr. J. A. Ratcliffe, of the Cavendish Laboratory, Cambridge, has been awarded the Holweck Medal and Prize for 1953 and will deliver the eighth Holweck Lecture in Paris on May 22; his subject will be "Some Aspects of Diffraction Theory". The Holweck Medal was founded by the Physical Society as a memorial to Fernand Holweck, director of the Radium Institute, Paris, and to other French physicists who were killed during the occupation of France in the Second World War, and the award is made annually by the Physical Society and the Société Française de Physique jointly. The recipient is alternately a French and a British physicist, distinguished for his work in experimental physics.

The Television Society's Silver Medal has been awarded for 1953 to Mr. George Cansdale, for his feature on the B.B.C. television programme in presenting animals from the London Zoo. This Medal, which was instituted in 1948, is intended to acknowledge the work done by an author, actor, producer, or any member of the television service in promoting the artistic or entertainment side of television programmes; and, in making the award this year, the Society has recognized that the function of television is not only entertainment but also education, both of which are combined in Mr. Cansdale's programmes.

The James Cook Medal for 1952 of the Royal Society of New South Wales has been awarded to Emeritus Prof. W. L. Waterhouse, of the University of Sydney, in recognition of his work in the field of agricultural science, particularly in the breeding of rust-resistant wheats. The James Cook Medal is awarded for "outstanding contributions to Science and Human Welfare in and for the Southern Hemisphere". The first award was made to Field-Marshal J. C. Smuts a short time before his death in 1950.

Dr. G. P. Contractor, who for the past three years has been the acting director of the National Metallurgical Laboratory of India, Tatanagar, of the Indian Council of Scientific and Industrial Research, has recently resigned from the Council.

Dr. C. J. Stubblefield, chief palæontologist since 1947 of the Geological Survey of Great Britain, has been appointed assistant director of the Survey and curator of the Museum of Practical Geology, London.

The following have been appointed to readerships tenable at St. Mary's Hospital Medical School, London: Mr. A. d'A. Bellairs (anatomy) and Dr. K. W. Cross (human physiology). The title of reader has been conferred on the following in respect of the posts held by them at University College, London: Dr. J. T. Aitken (anatomy) and Dr. G. E. Fogg (botany).

PETROLEUM CHEMICALS INDUSTRY IN GREAT BRITAIN

UNDER the joint auspices of the Society of Chemical Industry (London Section) and the Institute of Petroleum, a full day was devoted to a symposium on the "Production and Utilization of Petroleum Raw Materials in the U.K. Chemical Industry", which was held on March 2 at the Institution of Electrical Engineers, Savoy Place, London. Twelve papers, previously circulated, were briefly outlined by their authors, and discussion followed. The questioning was direct, though an understandable desire of industrial firms to retain their trade secrets led on occasion to reticence in giving equally direct replies. Throughout, the discussion was spirited; the wide range of subjects considered led, not to a diffusion of interest, but to a shaping and crystallization of views that was informative and helpful.

In opening the symposium, Mr. E. J. Dunstan (Manchester Oil Refinery, Ltd.) compared the earlier development of the petroleum chemicals industry in the United States with the growing British effort in this field. The natural conservatism in Britain of old-established industries and the inability of industrial organizations to pay for development projects out of earnings have impeded that growth and proliferation which are essential if the chemical industry is to make an adequate contribution to the well-being of the people and to the balance of trade. After making due allowance for the different economic climates of the United States and Great Britain and the industrial and commercial requirements and trends peculiar to the latter country which may invalidate arguments based on simple analogy, Mr. Dunstan concluded that the British petroleum chemicals industry requires substantial additional resources of capital, an increased intake of technically trained men (particularly chemical engineers) and the full collaboration of labour; otherwise its energetic beginnings which promised so much may die away, and the opportunities that this young industry offers for strengthening the national economy may well be lost.

This theme of the economic effect of the industry on our trading position was elaborated by Dr. R. F Goldstein (British Oxygen Co., Ltd.). The chemical industry as a whole has increased its production capacity since 1948 from £327 to nearly £500 million—an increase which compares very favourably with the expansion-rate of other industries in Great Britain and with that of the chemical industry in other European countries. To this increase, the petroleum chemicals industry has made a substantial contribution, at the cost of capital investment in the region of £40–50 million. If the British industry were to continue to grow at the same proportionate rate as the United States petroleum chemicals industry is expected to develop, according to the Paley Report, during the next twenty-five years, then additional capital investment at the rate of £14 million a year would be required, and the whole chemical industry would demand about £70 million a year for comparable expansion. The threat of capital starvation of the industry is real, and the hope of survival lies in the probability that the profit record of the chemical industry as a whole will prove a sufficiently strong attraction to new risk capital.

The technical basis of the industry was outlined by Dr. H. K. Whalley (British Industrial Solvents, Ltd.). Oil refining offers a range of raw materials extending from methane (which may be used for the production of synthesis gas, acetylene, hydrocyanic acid, etc.), ethylene, ethane, C_3s and C_4s, to the light distillates such as naphtha, kerosine and gas oil, which are the feed stocks for cracking processes specially developed for making olefines and aromatics for subsequent chemical conversion. Oil-refining processes such as thermal and catalytic reforming and thermal and catalytic cracking, which are designed primarily to give increased quantities of high-quality gasoline, also yield gases as by-products which serve as starting materials for the petroleum chemicals industry. Further, catalytic reforming processes developed by the oil industry for the octane-number improvement of gasoline and naphtha may be adapted for aromatics production. The conventional oil-refining industry is therefore making a dual contribution to the development of petroleum chemicals: it provides the charge stocks from which the essential olefines and aromatics may be made, and it aids the technological growth of the new industry by its own research, development and experience in cracking, alkylation, reforming and polymerization processes. These ties between petroleum refining and petroleum chemicals production are not restrictive: mutual benefits, both technical and economic, must come from the closest association of the two industries.

Two aspects of plant design and construction were dealt with by Mr. E. Smith (Firth-Vickers Stainless Steels, Ltd.) and Mr. E. O. Curtiss (The Lummus Co., Ltd.). The dangers of intergranular corrosion of unstabilized 18/8 austenitic steels, due to deposition of chromium carbide at grain boundaries, was strongly emphasized. Ordinary 18/8 steel, when reheated to 500–800° C., is rendered susceptible to this defect, but the risk can be eliminated if titanium or niobium is added to the steel. Though full details of a wide range of corrosion- and heat-resisting steels were given, Mr. Smith stressed the desirability of designers, fabricators and users consulting with steel manufacturers, so that the needs of each particular job could be more satisfactorily met.

Some problems in the design of plants for the recovery of light olefines from refinery and cracker gases were described by Mr. Curtiss, with emphasis on the absorption–fractionation method. The preliminary removal of sulphur and acetylene, followed by drying of the gas stream, was outlined, and the design and operation of the absorption–fractionation system were described in detail. The alternative process relying on low-temperature distillation and cascade refrigeration systems was also discussed, and the point was made that the relative merits of the two processes are dependent upon the nature of the feed stock and the required recoveries and purities of the product gas streams. In discussion, Mr. Curtiss observed that the hypersorption process, which relies upon the adsorption of gases by charcoal and their selective desorption, is less widely used, and the reason may lie in the difficulties in stripping the adsorbent and in its attrition.

The synthesis of ethyl alcohol by the catalytic hydration of ethylene at the Grangemouth factory of British Petroleum Chemicals, Ltd., is an outstanding manifestation of two of the major lines of

the petroleum chemicals industry, which were well recognized by the symposium. The first is the tendency of the industry to offer an alternative route to chemicals previously made from vegetable products, and the second is the application of catalytic methods which dispense with the need for heavy inorganic chemicals that contribute no essential ingredient to the finished compound. The cost of producing alcohol by fermentation of molasses is dependent largely on the price of molasses, which is itself dependent upon world sugar production, cattle feed requirements (particularly in the United States) and the varying demand for industrial alcohol. So influential have these and other factors been that, during the past twenty years, the price of Cuban molasses has ranged from £3 10*s.* to £25 a ton. By basing the production of ethyl alcohol on petroleum-derived ethylene, it is confidently expected that a more stable price-structure, and one set at an economically lower level, will result. In the United States, half of the industrial alcohol produced is synthetic alcohol. The decision having been made to adopt petroleum as the base for alcohol manufacture, a choice had to be made between the two methods available, namely, by the well-established process of absorbing the ethylene in sulphuric acid to obtain the ethyl esters which are afterwards hydrolysed, or by the Shell method of hydrating ethylene directly, phosphoric acid on 'Celite' (a diatomaceous earth) being used as the catalyst. Mr. A. J. Johnson, presenting the paper prepared by Mr. C. R. Nelson and himself (Shell Development Co.), described this second and preferred course which eliminates the problems involved in the use of sulphuric acid, including those of reconcentration of the acid, disposal of impure acid, and corrosion effects. The direct hydration of ethylene is conducted at about 1,000 lb./sq. in. gauge and 300° C.; the molar ratio water/ethylene is 0·6, and the conversion of ethylene per pass is low (about 4 per cent). The choice of these reactor conditions is largely determined by economic considerations.

Two other instances of new processes, which avoid the use of substantial quantities of inorganic chemicals, were the subject of papers. The economics of the catalytic direct oxidation of ethylene by air over a silver catalyst to yield ethylene oxide, in contrast to the older chlorhydrin process which consumes large amounts of chlorine and lime (about two tons of each per ton of ethylene oxide made), were presented by Dr. E. T. Borrows and Mr. D. A. Caplin (Petrochemicals, Ltd.). On the basis of conservative estimates of capital costs and yields, the direct oxidation process shows significant advantages, particularly under competitive market conditions, which may be expected to force down the selling price of ethylene oxide. The meeting showed a lively interest in the technical aspects of the process, which the economic calculations tacitly assumed, and questions were put on the patent position, the catalysts used, the need for moderators to suppress 'hot spot' formation, the tolerable acetylene concentration in the feed gas, and the carbon monoxide in the recycle. Published data on these points are, however, scanty, and those members of the meeting who may have been in a position to contribute information on these matters withheld their views. The strong attitude of caution in accepting the claimed merits of the direct oxidation process might be dispelled if at least some of the data from existing plants in the United States were made available and if performance reports on the plants at present under construction in the United States and on the Continent of Europe, couched in something better than meaningless general terms, could, in due course, be released. Though it would be foolish to expect trade secrets to be given away, the paucity of performance data prevents impartial assessment, and retards, by some years, the more widespread adoption of a process that may well be as good as the paper economics imply.

Mr. F. E. Salt (The Distillers Co., Ltd.) provided the third example of an elegant process which dispenses with the use of heavy inorganic intermediates. The well-established methods for synthesizing phenol from benzene rely upon using sulphuric acid or chlorine as basic raw materials, and involve corrosive conditions. The new process developed by the Distillers Co. and the Hercules Powder Co. converts benzene and propylene, via *iso*propyl benzene, to phenol and acetone. Its advantages have been judged to warrant the construction of a number of plants overseas which are expected to come into production soon. The essential basis of the process—that is, alkylation, followed by oxidation to the hydroperoxide and its decomposition to the corresponding phenol and ketone—is of wide applicability; for example, *sec.*-butyl benzene yields phenol and ethyl methyl ketone; *m*- and *p*-di*iso*propyl benzenes yield acetone with resorcinol and quinol, respectively. The capital cost of a plant to produce 10,000 tons phenol a year and 6,000 tons acetone a year is estimated to be £1·75 million, which is slightly less than that required for phenol plants of the same capacity employing older processes. Further, if reasonable values (for example, 1952 price-levels) are taken for raw materials, utilities, labour and for the acetone credit, then the cost of production of phenol by this route is about 70–80 per cent of that by any of the other routes.

An outline of the production of polystyrene and its utilization in a variety of industries, as presented by Dr. V. G. Bashford and Mr. S. D. Eagleton (Monsanto Chemicals, Ltd.), raised questions relating to the use of methyl styrene. It appears that the use of methyl styrene offers the possibility of more rapid polymerization, and though the polymers are less suitable for injection moulding, they promise well for incorporation in surface coatings. The advantages of toughened polystyrene in comparison, say, with toughened polyvinyl chloride were discussed, and doubt was expressed as to the ability of the product to retain over periods of three to four years the high impact strength and improved elongation that the freshly prepared material possesses.

The paper by Mr. W. G. Oakes and Mr. H. C. Raine (Imperial Chemical Industries, Ltd.) on polythene was of outstanding merit in demonstrating the best features of the scientific approach in carrying a project through research and development to full-scale production, followed by the subsequent elaboration of the first direct course, so that a wider range of products of desired and predictable properties may be made. The fundamentals of polythene formation have been carefully examined, and many techniques and approaches have been used to elucidate the polymerization process and the structure and nature of the product. At first believed to be a straight-chain polymer, polythene is now known to be made up of molecular chains that are branched. The application of X-ray diffraction, infra-red spectrographic analysis, studies of osmotic pressure

and viscosity of solutions, light scattering and other techniques have contributed to the present conception of the structure of polythene, but even now it is not fully resolved. Each finite sample of polythene is made up of molecules having quite a wide spread of molecular weight. The physical properties of the polymer depend upon both the chemical features and also on the arrangement of the molecules in relation to one another in the solid state. Polythene is partly crystalline: in the commercial material, probably about 70 per cent of the molecules are in the ordered state. The authors of this paper correlated chemical and structural features with electrical conductivity, melt viscosity, melt elasticity, softening point and mechanical and physical properties in the solid state. A point of interest which the discussion evoked was that, under the action of gamma-rays, cross-linking is caused, resulting in the transformation of polythene to a glassy, brittle solid. This effect is similar to that produced by a very prolonged photo-oxidation; the mechanism of the change is a matter for speculation.

A second paper from Imperial Chemical Industries, Ltd., on butane dehydrogenation, by Mr. E. Beesley and Dr. B. Whipp, was equally creditable as a record of the rapid development, in collaboration with Universal Oil Products, Ltd., of a process under the stress of war-time conditions of emergency and improvisation. A mixture of *iso* and *normal* butanes (usually 70 per cent *iso*) was dehydrogenated over an alkali-promoted chromia–alumina catalyst to the corresponding butenes. This essential step in the production of *iso*octane for aviation gasoline was brought to successful operation; one major difficulty, namely, the random choking of the reaction tubes due to excessive and unpredictable coke formation, was cured by introducing 30–40 p.p.m. carbon disulphide in the charge. The carbon disulphide was thought to passivate the tube material against alternate oxidation and reduction, thus preventing the catalysis of carbon formation by finely divided metal. In the discussion, it was said that the process is now in operation for the production of *iso*butene from *iso*butane in an integrated plant, wherein this step fits in with other industrial processes.

The separation and utilization of C_4 olefines, which are becoming increasingly available from the new oil refineries and petroleum chemicals cracking-plants, was reviewed by Dr. E. T. Borrows and Mr. W. L. Seddon (Petrochemicals, Ltd.). It is of particular interest that whereas the C_4 stream from oil-refinery catalytic crackers contains virtually no butadiene, the plants installed by petroleum chemicals works for the cracking of naphtha, gas oil, etc., yield a C_4 stream containing substantial amounts of butadiene. This constitutes both an opportunity and a problem. Considerable interest was shown in the authors' suggestion that, from a mixed C_4 stream containing butadiene, the *iso*butene may first be removed by selective absorption in sulphuric acid without absorbing appreciable amounts of the butadiene present; in fact, more than 90 per cent of the butadiene may be afterwards recovered.

The series of specialist papers was concluded by the paper by Dr. D. P. Dodgson (Monsanto Chemicals, Ltd.) on the use of additives based on petroleum for improving the quality of various petroleum fractions. A wide range of products, including chlorinated waxes, sulphonation products, naphthenic acids, viscosity index improvers, pourpoint depressants, etc., were dealt with. In the discussion, interest was shown in the use of additives to give oils of both high- and low-viscosity indices, and in the liability of viscosity index improvers to break down at high rates of shear. Dr. Dodgson gave the assurance that conventional lubricating oils containing additives from different manufacturers are, in general, mutually compatible.

Sir Robert Robinson, in the closing address, pointed out that the world chemical industry is highly competitive, and, if the British complement is to survive, it must keep in the race: any early financial losses in establishing the petroleum chemicals industry must be accepted; national and strategic interests make it imperative that the necessary capital to sustain development and growth of the industry must be found. The symposium, he said, rightly laid stress on an essential theme of this new industry: that is, its facility for developing alternative processes which do not require the use of substantial quantities of heavy inorganic chemicals, for example, in the production of acetone and phenol by the Distillers Co., Ltd., process, and of ethylene oxide by the catalytic oxidation of ethylene. This theme should be vigorously developed. Research over a broad front on catalysis should be conducted, and in this attack, continued Sir Robert, government departments such as the Chemical Research Laboratory and the Fuel Research Station of the Department of Scientific and Industrial Research should play an outstanding part. Recent research has demonstrated that there are many reactions and processes which hold high promise of industrial exploitation in Britain: the Fischer–Tropsch reaction and the Oxo syntheses are well-known examples. The recent work of Ziegler on the use of lithium and aluminium hydrides as catalysts in controlled polymerization processes may also lead to economic routes to both known and new products. These are only examples of the many opportunities, some known, some awaiting discovery, that lie before us, and only by our own energy and unsparing effort can they be won.

CLAY – WATER RELATIONSHIPS

A MEETING of the Clay Minerals Group of the Mineralogical Society, held at the laboratories of the British Ceramic Research Association, Stoke-on-Trent, during November 7–8 last, was devoted to a discussion upon clay – water relationships. The meeting was preceded, on the morning of November 7, by a visit to the laboratories of the Association. At the scientific sessions the chair was taken on the afternoon of November 7 by Dr. G. W. Brindley (University of Leeds), and on the morning of the following day by Dr. G. Nagelschmidt (Safety in Mines Establishment, Sheffield).

The discussion was opened by a review of the significance of clay – water relationships in ceramics by D. A. Holdridge and F. Moore (British Ceramic Research Association). Plasticity and strength data as well as the Pfefferkorn and modified Pfefferkorn numbers for ball and china clays were related to dehydration data, and discussed in relation to the concept of 'planar' and 'broken-bond' water; the former is removed below 110° C., but removal of the latter is incomplete below about 250–275° C. In describing the rheological properties of importance

for clay slips and pastes, particular attention was paid to the methods for determination of viscosity and plasticity and their applicability. The rheology of thixotropic gels was also discussed. In the discussion, the different dehydration characteristics of china clay and ball clay were commented upon by R. Greene-Kelly (Rothamsted Experimental Station, Harpenden) and by Dr. Brindley, who also referred to recent dehydration data for nacrite[1]. G. K. Jones (Fuller's Earth Union, Redhill), Dr. N. O. Clark (English Clays, St. Austell) and Mr. Moore discussed the relationship of dilatancy, turbulence and shearing, and R. H. S. Robertson (Glasgow) inquired about the relationship of the modulus of rupture to the moisture content.

Soluble salts may have deleterious effects upon clay products—for example, efflorescence in bricks—and the determination of these in clayey raw materials was discussed by Prof. H. Lehmann (Bergakademie, Clausthal-Zellerfeld), who showed that extraction by a percolation method after firing gives the most useful information. Using this technique, it has been found that efflorescence is not related to the amount of soluble salts alone, but that it is also dependent upon pore space, pore characteristics, firing temperature and the density and chemical characteristics of the specimen. Correlation of efflorescence with firing temperature, the effect of various ions and the possibility of control of conditions leading to efflorescence were discussed. In reply to comments by B. Butterworth (Building Research Station, Watford), Prof. Lehmann stressed that he had considered only clays in which his laboratory is interested, and agreed that higher sulphate contents are not uncommon; he also mentioned that, in Germany, determination of soluble salts in the raw material is still used to assess a clay. Other speakers referred to the effect of association of bricks with cement products and the question of the total soluble salts. In reply to W. Noble (British Ceramic Research Association), Prof. Lehmann remarked that the effect of the *p*H of the extracting solution has not yet been considered.

The deflocculation of kaolinite suspensions and its relationship to chloride adsorption has been investigated by Dr. R. K. Schofield and H. R. Samson (Rothamsted Experimental Station), who found that a flocculated sodium–kaolinite suspension in contact with less than a critical amount of sodium hydroxide takes up chlorine ions from dilute sodium chloride solution; when deflocculation occurs, full negative adsorption is observed. These results are related to questions of cation-exchange by kaolinite, since, from the observations made, exposed hydroxyl groups at the surface would only be expected to give exchangeable hydrogen ions under alkaline conditions. In addition, montmorillonoids might, under certain conditions, be sorbed by kaolinite to neutralize positive charges. Mr. Greene-Kelly and Dr. Clark both commented upon the significance of the above results in work involving dispersion of mixtures of clay minerals, where one mineral may be preferentially deflocculated. Dr. D. M. C. MacEwan (Rothamsted Experimental Station) pointed out that the remarks upon dissociation of hydroxyl groups were in disagreement with the views of Edelman and Favejee[2], and that the results might be significant in determining the true structure of montmorillonite[3].

To investigate the relationship between viscosity and concentration for three clays of the kaolin group, T. E. Currie and Dr. R. W. Grimshaw (University of Leeds) employed electron-optically checked samples of uniform particle-size. The viscosity/concentration curves were all similar in shape and could be derived from equations employing a series of constants dependent upon degree of dispersion, upon particle-size, and upon type of clay mineral present. In general, the viscosity was more dependent upon particle-size than upon type of mineral. Dr. Grimshaw, replying to Dr. Nagelschmidt, reported that constant shearing stress had been used, although the same general conclusions were applicable under different conditions. Dr. Clark questioned whether the relatively constant thickness-ratio for kaolinite grains in the various fractions could be taken as a universal rule, and in this connexion Mr. Robertson referred to some work upon the relationships of viscosity to rugosity[4] and to particle size for various kaolin clays[5]. The rigidity of the water envelope around clay particles and its effect upon results were also discussed by Dr. Clark and Dr. Grimshaw.

In a review of the subject of thixotropy and the internal swelling of crystals, Prof. U. Hofmann (Technische Hochschule, Darmstadt) described a very neat method, employing freeze-drying technique, of obtaining dry undisturbed clay-gel structures for examination under the electron microscope. These structures alter very little in volume during drying, and it is considered that the relative positions of particles are virtually unchanged; the framework is reasonably solid, very stable and even has a certain elasticity—properties which were demonstrated by a sample passed among members of the meeting. The effect of electrolytes upon the volume of coagulated clay gels, and the forces operative here and in maintaining the solidity of the framework were discussed. Prof. Hofmann also reported the results of an investigation upon thixotropy in non-aqueous liquids, for example, hexane and benzene. In the discussion, Dr. Nagelschmidt referred to the occurrence of thixotropy in systems with spherical particles, and Mr. Samson, Dr. Clark and Prof. Hofmann discussed general questions upon thixotropy and the arrangement of particles in flocculated systems. The formation of dipoles, and the dielectric constants of suspensions were referred to by Dr. Clark and Mr. Jones, and finally Prof. Hofmann, in addition to Dr. Clark and Dr. P. Howard (University of Leeds), suggested other methods whereby dry, undisturbed clay structures might be produced.

The conditions under which montmorillonoids lose their expanding properties on heating were described by R. Greene-Kelly, who related the changes occurring with crystal structure[6]. For example, if lithium-saturated montmorillonoids are heated to 200° C. and treated with glycerol, only dioctahedral components with the charge in the tetrahedral layer (that is, the beidellite type) will swell. Reference was made to the sorption of water by sodium-montmorillonoids, and some notes were given upon the information to be derived from such measurements. Mr. Greene-Kelly, in reply to Dr. R. C. Mackenzie (Macaulay Institute, Aberdeen), reported that he had not examined beryllium-montmorillonoids because of the hazards of the acidity of stable solutions of Be^{2+} salts. Further discussion took place upon the effect of lithium ions upon the cation-exchange capacity of montmorillonoids and the possibility of such ions entering the lattice, these points being raised by Dr. Nagelschmidt and Dr. B. S. Neumann (Fuller's Earth Union).

Dr. G. W. Brindley and R. F. Youell (University of Leeds) showed that, during the oxidation of

ferrous to ferric chamosite, there occurs a partial dehydration which can be related to the lattice positions of the hydroxyl groups. The retention of water and structural order to high temperatures during the dehydration of nacrite[1] was also demonstrated. These results were considered in relation to oxidation–dehydration processes in other minerals, and, as an example, it was shown that chemical analyses for decomposition products of biotite[7] can only give reasonable structural formulæ using assumptions derived from the above experiments. The derivation of good structural formulæ was commented upon by Dr. MacEwan, Dr. Nagelschmidt and Dr. Mackenzie, while Dr. S. J. Gregg (University College, Exeter) compared the retention of water by silicates to a high temperature with the retention of water and carbon dioxide by other compounds. Dr. H. P. Rooksby (General Electric Co., Wembley) referred to the retention of water by γ-Al_2O_3, and, in reply to his questions on the structural dehydration data, Dr. Brindley stressed the slowness of heating and the reproducibility of results even with broken crystals. The mechanism of the dehydration of kaolinite, with special reference to the work of White *et al.*[8], was also discussed by Dr. Nagelschmidt, Dr. Grimshaw, Dr. Howard, Mr. Youell and Dr. Brindley.

The final paper was not upon the subject for discussion although it had an indirect connexion. In order to determine the effect of grinding on kaolinite, Dr. S. J. Gregg, T. W. Parker (English Clays, St. Austell) and Mrs. M. J. Stevens (University College, Exeter) ball-milled a sample for a thousand hours, withdrawing aliquots at intervals for various physical and chemical tests—for example, X-ray examination, air sedimentation, loss on ignition, etc. Up to six hundred hours, the primary particles were decomposed chemically as well as broken physically, and the products formed an amorphous layer on the somewhat disorganized, undecomposed particles. The resultant particles, which possess an internal area, resisted complete dispersion and, after six hundred hours, the proportion of stable aggregates increased. During discussion, questions were asked by Mr. Greene-Kelly, Mr. Henderson, Mr. Jones, Dr. Neumann, Dr. MacEwan, I. L. Freeman (London Brick Co., Stewartby) and Dr. Mackenzie upon the method of sampling, the wear on the ball-mill, the uniformity of particle size, density measurements and the stability of aggregates. The possibility of interference of electrostatic charges with air-sedimentation tests was suggested by Dr. P. L. Plesch (University College, Stoke-on-Trent), and, in reply to a question by Mr. R. Johnson (British Ceramic Research Association), Dr. Gregg pointed out the significance of the inter-relationship of measurements of bulk density, sedimentation and surface area. The X-ray results were discussed by Dr. Brindley and E. K. Cundy (English Clays) and the amorphous coating, or 'Beilby layer', by Mr. Robertson.

Before the end of the meeting, two brief reports—one on the conference on clays and clay technology, held at the University of California during July 21–52, 1952, and one on the meetings of the Comité International pour l'Étude des Argiles, held in conjunction with the Nineteenth International Geological Congress, Algiers, during September 8–15, 1952—were presented by Dr. MacEwan and Dr. Mackenzie, respectively.

This meeting, as a whole, proved most valuable, giving ample proof of the significance of clay – water relationships in all aspects of clay studies, both pure and applied. Its value was enhanced by the concentration on problems which our present knowledge is insufficient to solve, but which might well form the subject of future research.

ROBERT C. MACKENZIE

[1] von Knorring, O., Brindley, G. W., and Hunter, K., *Min. Mag.*, **29**, 963 (1952).

[2] Edelman, C. H., and Favejee, J. Ch. L., *Z. Krist.*, A, **102**, 417 (1940); and Edelman, C. H., *Verres et Silicates Indust.*, **12** (Supp.), 3 (1947).

[3] For example, see *Nature*, **168**, 107 (1951).

[4] Robertson, R. H. S., and Emödi, B. S., *Nature*, **152**, 539 (1943).

[5] Meldau, R., and Robertson, R. H. S., *Ber. deut. keram. Ges.*, **29**, 27 (1952).

[6] For earlier work see Greene-Kelly, R., *Clay Min. Bull.*, **1**, 211 (1952).

[7] Walker, G. F., *Min. Mag.*, **28**, 693 (1949).

[8] For example, see Vassiliou, B., and White, J., *Clay Min. Bull.*, **1**, 80 (1949); and Murray, P., and White, J., *ibid.*, **1**, 84 (1949), and *Trans. Brit. Ceram. Soc.*, **48**, 187 (1949).

RADIO RESEARCH IN THE BRITISH COMMONWEALTH

AT the meeting of the British Commonwealth Scientific Official Conference in 1946, a Specialist Conference on Radio Research was convened and was held in London during August 1948 under the chairmanship of Dr. R. L. Smith-Rose. The proceedings of this Conference, which were published (S.O. Code No. 47–148–1949; London: H.M.S.O.; 4*d*. net), included a number of recommendations designed to encourage the Commonwealth countries to participate more actively in a comprehensive programme of fundamental radio research. This programme included such items as proposals for the location of ionospheric recorder equipment for determining the characteristics of the ionosphere at vertical incidence, the study of the propagation of radio waves at oblique incidence and the comparison of radio transmission forecasts with the results of the practical operation of radio circuits. Other matters were concerned with radio noise of both terrestrial and extra-terrestrial origin, the investigation of meteors by radio methods, and with a study of the effect of meteorological conditions on the propagation of very short radio waves. Suggestions were also made for extending the limited services of standard frequency transmission, and for collecting information to increase our knowledge of the electrical constants of the ground in all parts of the Commonwealth.

The progress made towards the implementation of these recommendations has been reviewed on two occasions by correspondence through the British Commonwealth Scientific Liaison Offices in London; and last August in Sydney, Dr. Smith-Rose held another meeting of the Specialist Conference, taking advantage of the presence there of a number of radio scientists attending the General Assembly of the International Scientific Radio Union. It was noted that considerable progress has been made in extending the network of ionospheric recording stations throughout the Commonwealth. In addition to the stations in Great Britain at Slough and Inverness, the United Kingdom has maintained similar stations at Singapore and in the Falkland Islands; and more recently an experimental equipment has also been in operation at Port Lockroy in Antarctica. Furthermore, similar recorder equipment has been installed by the United Kingdom Department of Scientific and Industrial Research at Ibadan, Nigeria, and at Khartoum, where it is now being operated by the University

College authorities at those places. The Canadian authorities have installed new stations at Fort Chimo, Resolute Bay and Baker Lake; and South Africa has assisted the Belgian Congo authorities to build a station at Leopoldville. The Australian Radio Research Board responded very actively to the recommendation that a chain of ionospheric observatories should be operated in the vicinity of longitude 150° E. by setting up recorders at Hobart, Canberra, Brisbane and Townsville. Furthermore, a station has been set up at Macquarie Island which should be of great assistance in the study of ionospheric conditions in antarctic regions. In India, ionospheric recorders of various types have been installed at Delhi, Calcutta, Ahmadabad and Kodaikanal.

Research on the absorption of radio waves travelling through the ionosphere is being actively pursued in the United Kingdom and in Australia, Canada and India; and the results are used, with other ionospheric information, in a comparison of radio transmission forecasts with practical results. Investigations are also in progress in most Commonwealth countries with the view of improving the forecasting of ionospheric storms, which on occasions cause serious interruption of practical radio services, including communication and broadcasting.

For several years past, measurements of the atmospheric radio noise-level prevailing at frequencies of 2–20 Mc./s. have been made by a subjective method at some twelve stations in various countries; and development work is in hand to extend this investigation to frequencies of 15–500 kc./s. in order to provide more direct information on the performance of low-frequency radio aids to navigation. Fundamental investigations on atmospheric disturbances, including in some cases a detailed study of waveforms, are in progress in the United Kingdom, India and South Africa. A recommendation was made at the Sydney meeting that the high-frequency noise-measuring equipments in Australia and New Zealand should be put into operation again as soon as possible, since continuity of the study of atmospheric noise for several years all over the world is essential for the ultimate improvement of the efficiency of operation of all radio services.

Following a recommendation made at the London meeting in 1948, the New Zealand authorities have been able to initiate in the southern hemisphere the study of meteors by radio methods, as a field of research complementary to that pursued in the United Kingdom. The collaboration between the two countries has been very effective, and it is now recommended that the work in New Zealand should be continued and extended so far as practicable.

The extremely short-wave portion of the radio spectrum is likely to be of very great importance to the future of radio services of all types. With this in mind, a strong recommendation was made at the Sydney meeting that research on tropospheric wave propagation should be vigorously pursued in all countries in order to improve our knowledge of the influence of different climatic conditions on the possible correlation between radio propagation and meteorological conditions. A considerable amount of investigation work in this field has been conducted during recent years in New Zealand, and in the United Kingdom; but there is a need for a continued study of the effects experienced under different conditions and at various frequencies in order to assist those responsible for planning future radio systems and services.

The extensive research work on solar and cosmic noise, which is now embraced under the general title of 'radio astronomy' and which has been pursued in several countries, notably in Australia and the United Kingdom, is too well known to need any detailed reference here. It may be remarked, however, that the meeting in Australia of the International Scientific Radio Union provided an excellent opportunity for some of the workers in this field to meet and discuss matters of mutual interest, and particularly to compare the results of experience in the northern and southern hemispheres.

In February 1950 the United Kingdom established a limited regular service of standard-frequency transmissions from the Rugby radio station of the General Post Office, using the call-sign *MSF*. The service provides transmissions for short periods daily on frequencies of 60 kc./s. and on 5 and 10 Mc./s. These transmitted frequencies are monitored by the National Physical Laboratory, and the latter's observations show that over a period of a day the frequency remains constant to about 1 part in 10^9, a slow drift of frequency over longer periods being corrected whenever the deviation from the nominal value approaches 2 parts in 10^9. Apart from this service, the Union Observatory in South Africa radiates time signals, and a standard frequency transmission is made on low power from Johannesburg. The Australian authorities are also exploring the possibilities of establishing a standard-frequency service to meet local requirements in that continent.

With regard to the measurement of the electrical characteristics of the ground at radio frequencies, in Canada, South Africa and South-West Africa, surveys of conductivity by radio methods have been in progress for some years; and the All-India Radio organization is starting systematic measurements of the electrical properties of the ground throughout India. It is realized that this type of investigation should be pursued in close association with a study of the effects of the contours of the terrain on ground-wave propagation at various frequencies. It is considered, however, that the original recommendation should be retained with the view of encouraging Commonwealth radio organizations to collect all appropriate information on measurements made in their own countries, to facilitate the preparation by the United Kingdom of a survey of existing knowledge of the electrical constants of the ground at radio frequencies.

HUMAN FACTORS IN INDUSTRY

TWO committees to work on human problems in industry have been set up jointly by the Department of Scientific and Industrial Research and the Medical Research Council, one being concerned with human factors in individual efficiency, and the other with human relations. The division of interest between the committees is broadly that the first will study the individual worker and his job, and the second such things as the relation between the manager and the worker, between the worker and his mates and between the foreman and the technical specialist.

The subjects to be considered can be listed under four headings, the first three of which are, in general, the responsibility of the committee on industrial efficiency, and the fourth is that of the committee on

human relations: fitting the job to the man—work on the design of tools and working equipment to suit the man who uses them (which is getting more important as machines become more complicated), time and motion study, and the effect of factory lighting, heating and noise, etc., on performance; selection and training; assessing the job—work measurement, job appraisal, time and motion study as a means of assessing a fair day's work, etc.; human behaviour and human relations—joint consultation, attitudes to work and the structure of informal groups in the factory. For research on matters relating to occupational health, the Medical Research Council will continue to be responsible, advised by its own special committees. However, in order to secure co-operation on technical aspects, the Department of Scientific and Industrial Research will be asked to appoint assessors to these committees where appropriate; for example, the elimination of dust from factories, although primarily a medical problem, may bring in the Department or the research associations to develop means of combating dust.

The scientific study of the human factors in industry is not, of course, a new venture: notable contributions have come in the past from the researches of the Medical Research Council's Industrial Health Research Board on, for example, how hours of work affect output and health, the influence of environmental factors such as lighting and heating, and the effects of incentives; and the Panel on Human Factors of the post-war Committee on Industrial Productivity has also done important work, including an investigation of the foreman in British industry. However, the need for much more of this kind of research is realized, and the aim of the two new committees will be to develop knowledge which can be used to make definite recommendations, the underlying object being to improve industrial production in Great Britain. For this reason, the committees include persons from industry, trades unions and universities.

Committee on Individual Efficiency in Industry. The terms of reference of this committee are: "(1) To keep under review the progress of knowledge bearing on the technical efficiency of the individual in industry. (2) To advise on general policy in research, including applied research and field study. (3) To call attention to gaps, and make recommendations for filling them. (4) To consider and report from time to time on the requirements for the training of research workers and technologists in this field". Its members are as follows: Sir Frederic Bartlett (*chairman*) (formerly professor of experimental psychology, University of Cambridge), W. V. Beard (general secretary, United Patternmakers' Association), J. O. Blair-Cunynghame (chief personnel officer, British Overseas Airways Corporation), Prof. J. V. Connolly (Department of Aircraft Economics and Production, College of Aeronautics, Cranfield, Beds), J. Crawford (general president, National Union of Boot and Shoe Operatives; member of the Advisory Council, Department of Scientific and Industrial Research), Prof. J. Drever (Department of Psychology, University of Edinburgh), Dr. C. B. Frisby (director, National Institute of Industrial Psychology, London), L. V. Green (head of the Personnel Research Department, Dunlop Rubber Co., Ltd.), Prof. Esther M. Killick (Department of Physiology, Royal Free Hospital School of Medicine, London), Prof. W. E. Le Gros Clark (Department of Human Anatomy, University of Oxford), N. G. McCulloch (deputy chairman, Calico Printers' Association, Ltd.; chairman, Council of the British Cotton Industry Research Association), Prof. R. W. Russell (Department of Psychology, University College, London), Miss Nora Wynne (director, Carr's Biscuits, Ltd.), and an assessor from the Ministry of Labour and National Service. The joint secretaries are Dr. B. S. Lush (for the Medical Research Council) and Winston Rodgers (for the Department of Scientific and Industrial Research).

Committee on Human Relations in Industry. The terms of reference of the committee are: "To examine current activities concerning the study of human relations in industry and to call attention to problems of special timeliness or promise on which research, including applied research and field study, might be undertaken or supported by the Department of Scientific and Industrial Research, the Medical Research Council, or other bodies". Its members are as follows: A. B. Waring (*chairman*) (chairman and managing director, Joseph Lucas Industries, Ltd.), J. Foster Beaver (chairman, Beaver and Company (Bingley), Ltd.), J. O. Blair-Cunynghame (chief personnel officer, British Overseas Airways Corporation), A. D. Bonham-Carter (head of the Personnel Division, Unilever, Ltd.), Prof. T. Ferguson (Department of Public Health, University of Glasgow), E. Fletcher (member of the Advisory Council, Department of Scientific and Industrial Research; head of the Productivity Department, Trades Union Congress), Miss Beryl Foyle (joint managing director, Boxfoldia, Ltd.), Prof. A. J. Lewis (Institute of Psychiatry, University of London; and member of Medical Research Council), Prof. R. W. Russell (Department of Psychology, University College, London), Miss B. N. Seear (Department of Social Science, London School of Economics), Prof. T. S. Simey (Department of Social Science, University of Liverpool), W. R. Verdon Smith (managing director, Bristol Aeroplane Co., Ltd.), T. Williamson (General Council, Trades Union Congress), Dr. A. T. M. Wilson (director, Tavistock Institute of Human Relations), and an assessor from the Ministry of Labour and National Service. The joint secretaries are J. R. Gass (for the Department of Scientific and Industrial Research) and Dr. B. S. Lush (for the Medical Research Council).

TEACHING OF NATURAL SCIENCE IN SECONDARY SCHOOLS

IN view of the pressing needs for a more thorough and efficient teaching of science, a comparison and free flow of ideas between teachers, of all nations, of this subject would be useful. A number of accounts of different aspects of comparative education have been published by the United Nations Educational, Scientific and Cultural Organization, and a recent volume, "The Teaching of Natural Science in Secondary Schools"*, is compiled from information supplied to the International Bureau of Education, Geneva, by the ministries of education of all countries, apart from the U.S.S.R. and its satellite States. This is a valuable piece of work, and such efforts are to be encouraged; but it suffers from undue compression, as well as vagueness and scrappiness of

* Unesco: International Bureau of Education. Publication No. 139: XVth International Conference on Public Education, convened by Unesco and the I.B.E., Geneva, 1952. Teaching of Natural Science in Secondary Schools. Pp. 216. (Paris: Unesco. Geneva: I.B.E. London: H.M.S.O., 1952.) 5 Swiss francs or 8*s.* 6*d.*

treatment at times. Sometimes it gives a statement of intentions and ideals rather than of achievements; some of the accounts of science-teaching are clearly derived from those of other nations, and at times we do not get a clear idea of what is meant by secondary education. The vagueness of the official statement which does not want to commit itself to well-defined terms seems to be common to many countries. An example of this (which could be multiplied many times throughout the book) taken from the United Kingdom (England and Wales) Section will show the difficulties of the compiler: "Natural Science teaching is sometimes optional. It is left to the discretion of the individual school. The same importance is given to Natural Science in comparison with other subjects in promotion examinations and the Secondary School leaving examination".

The book is a sequel to an "Introduction to Natural Science in Primary Schools", prepared by the International Bureau of Education for the Twelfth International Conference on Public Education, held in 1949. The teaching of physics and chemistry is reserved for a later inquiry, and so the present work is confined to biology and its branches, physiology and anatomy, geology and mineralogy. To take away physics and chemistry from a report on science teaching would seem to be unfortunate. A definition of natural science which purposely excludes the fundamental studies of the physical sciences is unwise, and in any event they are not excluded in the reports which are sent in by some of the ministries. The information was given under a number of headings: the place of natural science in the curriculum, the aims of natural science teaching, syllabuses, teaching methods (including visual aids and text-books), teaching staff and future intentions. It is impossible to summarize further the results of the inquiry as they are set forth in the general survey in the early part of the book; but much of the information sent from forty-eight countries would have been grasped more readily had it been set out in tabulated form. It is evident that the countries concerned are unanimous in wishing to make natural science teaching more experimental and to bring it into closer touch with life, and that there is an increasing emphasis on the biological aspects of the subject. Science teaching in nearly all countries is related to human needs—individual, national and social. Some countries, including Germany, stress the ethical and philosophical aspects of science, its disciplines and opportunities for patience and criticism; the United Kingdom mentions its interest and hobby values; other countries indicate its relation to geography and its value as a means to a better understanding and use of the natural resources of the country.

The account of science teaching in England and Wales is disappointing, and does not do justice to work which is being carried on. To a foreign reader it must seem unimpressive. A clear statement should have been given of the division of secondary education in Britain, since the 1944 Act, into 'grammar', 'technical' and 'modern'. The report is chiefly concerned with modern schools (the old 'central schools'); grammar schools are only mentioned in passing, and secondary technical schools not at all. Although it is important that all citizens should leave school with some knowledge of biology, particularly in regard to the nature and needs of mankind, the fact remains that in Britain it is the grammar and public schools to which we must look for the type of science teaching which in the end produces scientists and technologists. The national and international value of the science teaching in these schools from 1902 until 1944 cannot be over-estimated. The need of the future for the type of scientific worker who comes from these schools is greater than ever before; indeed, there will be no future for Britain unless its life is sustained by an increasing number of workers thoroughly trained in the skills and disciplines of science. With the best will in the world, the modern schools do not meet these needs, in spite of the fact that they cater for the majority of children. Some of them do not teach science, many of them have no adequate course for the important age-group of 14–15 years, and, in spite of the optimistic Ministry of Education booklets mentioned in the report under review, some of these schools have not yet given adequate thought to their schemes of work. So far as the scientific life of the nation was concerned, the grammar and public schools laid the golden eggs; but they have been inhibited in their work by factors which could have been foreseen in 1945. No science graduate with a good honours degree needs to consider teaching as a career unless he has strong vocational leanings. Recruitment for the science staffs of grammar schools is suffering in both the quantity and quality of applicants to fill the vacancies. This has its repercussions on the attainments of students reaching the universities and on their subsequent value to society. Nor is this improved by feeble official attempts to assure us that the position is not unsatisfactory.

The document makes no attempt at appraisal of the various aims and methods, nor does it stress particularly good or original points where they appear. It will be of more interest to the student of comparative education than to the practical science teacher, who will find that it does not touch the fringe of most of the matters so admirably dealt with in the report on the "Teaching of General Science", prepared by the Science Masters' Association in 1950.

W. L. Sumner

SOCIAL ANTHROPOLOGICAL STUDIES OF LATIN AMERICA

THROUGHOUT Latin America there is a desire to improve conditions and to overcome difficulties which hinder national development, the greatest being the low estate of the Indian. In order to do this the first necessity is adequate information about things as they are, and the Institute of Social Anthropology of the Smithsonian Institution is helping to provide it by publishing a series of descriptive studies, of which Nos. 10–14 have been published during the past two years or more*. The policy of the Institute is to co-operate wherever possible with the various national organizations, and the present series owes much to students of the Mexican Escuela

* Smithsonian Institution: Institute of Social Anthropology. Publication No. 10: Nomads of the Long Bow; the Siriono of Eastern Bolivia. By Allan R. Holmberg. Pp. iv+104+7 plates. 65 cents. Publication No. 11: Quiroga, a Mexican Municipio. By Donald D. Brand, assisted by José Corona Núñez. Pp. v+242+35 plates. 1·75 dollars. Publication No. 12: Cruz das Almas, a Brazilian Village. By Donald Pierson and others. Pp. x+226+20 plates. Publication No. 13: The Tajin Totonac, Part 1, History, Subsistence, Shelter and Technology. By Isabel Kelly and Angel Palerm. Pp. xiv+369+33 plates. 2·75 dollars. Publication No. 14: The Indian Caste of Peru, 1795–1940: a Population Study based upon Tax Records and Census Reports. By George Kubler. Pp. vi+71+2 plates. 75 cents. (Washington, D.C.: Government Printing Office, 1950–1952.)

Nacional de Antropología e Historia, the Brazilian Escola Livre de Sociologia e Política of São Paulo, and the Peruvian Instituto de Estudios Etnológicas.

The author of No. 10 spent about eighteen months studying the unacculturated remnants of the Siriono, a very primitive naked tribe living in the tropical forests of Eastern Bolivia. For a third of this time he and a Bolivian companion lived alone with a small group. Conditions were very difficult, and his time was cut short by the entry of the United States into the Second World War in 1942, so he is not satisfied that he really understood the Siriono ; but he collected a lot of information about their material culture, activities, beliefs and social organization, which is set forth in a good straightforward description. In the final chapter, he analyses their culture in terms of "drives", of which the chief is hunger.

No. 11, dealing with a municipality of mixed white, mestizo and Tarascan Indian population near Lake Pátzcuaro in Michoacan, Mexico, is by a human geographer. It is a detailed and interesting description of selected aspects of life in Quiroga, with emphasis on land settlement, government and economy, little attention being paid to sociology because a colleague was studying it in a neighbouring town (No. 6 of the series). The area is well known to ethnologists from the survival of primitive methods of hunting birds on the lake, and is at present the scene of a Unesco welfare project.

A detailed account is given in No. 12 of a village near São Paulo, to which the imaginary name of Cruz das Almas was given to preserve anonymity. It was picked out as a typical Brazilian rural community of mixed European, Indian and African descent, depending mainly on agriculture. It proved to be homogeneous and stable, with no very striking features and practically no vestiges of aboriginal Indian culture.

By contrast, No. 13 deals with the district around Tajin, a Mexican area of great historical and archæological interest, with a rich material culture about which it is a mine of useful information. The population is Totonac, and their culture is a living one compounded from old and new elements. The historical background is particularly necessary to its understanding, and a good deal of the report is devoted to this, Isabel Kelly, as an archæologist, being well qualified to deal with it. This first part, covering history, subsistence, shelter and technology, makes a substantial volume ; and clothing, with several other aspects of material culture, together with what is described as non-material culture, will form Part 2.

No. 14, "The Indian Caste of Peru, 1795–1940", is a product of Dr. George Kubler's researches among the official archives of Peru while working in Lima during 1948–49. Although the word 'caste' is used in the title in association with the Indians, the Spanish word *casta* was generally used in Peru to refer to mestizos, albeit rather loosely as the author explains in detail. The work is a study of the variations in the percentage of Indians in the total population since just before the Independence. It seems that the Indian proportion rose during the first few years of the period studied, thus reversing a trend that had existed since the Spanish conquest, but that the fall afterwards continued, so that Indians now form about 40 per cent of the population. The problem is much complicated by the difficulty of defining an Indian, since the definition depends not wholly on biological factors but very considerably on social ones also.

ACCELERATING EFFECT OF AN EXTRACT OF VERNALIZED EMBRYOS OF WINTER RYE ON FLOWER INITIATION IN UNVERNALIZED EMBRYOS

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THE theory that flowering requires the presence of some specific flower-forming substance is rejected by some writers on the grounds that the application to uninduced plants of extracts of induced plants has not led to flowering or at best given inconclusive results. This argument is not, however, valid, since the active materials, which are known to move about in the plant and to pass a graft union, may well be inactive in a plant extract. Possible causes of failure are manifold : the solvent may fail to extract the substance, or may inactivate it ; it may not be absorbed by the test plant in sufficient quantity to produce a determinable effect, or it may only be active in association with the living protoplasm.

Small effects of plant extracts have been reported from time to time. Bonner and Bonner[1] induced flowering in *Xanthium* by applying an aqueous extract of the stem apex of *Washingtonia robusta*. Loehwing[2] and Behrens[3] report activity of extracts of *Zea mays* and *Sempervivum*, respectively. Sironval[4] obtained an oil from leaves of induced strawberry plants which, applied to leaves of young plants, led to normal flowering in a proportion of the plants treated, while the control plants produced rather fewer inflorescences and no fully developed flowers. Roberts[5] found that extracts of various plants in a flowering condition had a slight inductive effect on *Xanthium*. On the other hand, Melchers and Lang[6] report that careful experiment has failed to extract any florigenic substance.

In these examples the extracted plants were brought into the flowering condition by photoperiodic treatment. It therefore seemed necessary to determine if extracts of vernalized grain could confer the vernalized condition on plants which had not received this treatment. In 1951, embryos were removed from rye grain which had been vernalized for ten weeks, and were extracted with water, chloroform, ethyl alcohol or ether. The extracts, after removal of the solvents, were added to a sucrose agar medium[7]. Unvernalized embryos were excised and grown for six days on this medium, at a concentration which presented to each test embryo the extract of ten vernalized embryos. A control series was germinated on medium without extract. The seedlings were planted out in sand culture.

The results of this experiment are given in Table 1. Unfortunately a single plant in the control series flowered in 118 days : such early flowering had not been encountered in unvernalized plants grown from excised embryos, though it is fairly frequent when intact unvernalized grain is used. In the table it will be seen that despite the inclusion of this obviously aberrant plant the 'score', that is, progress to flowering[8], of the control series is more than six points below that of the series treated with chloroform

Table 1. Effect of Extracts of Vernalized Embryos on Plants Grown from Unvernalized Embryo 'Scores'

No extract		Extracts of vernalized embryos in various solvents			
Whole grain	Excised embryos	Water	Chloroform	Ether	Alcohol
(20) 27±2·0	(14) 22±3·6 (*a*)	(13) 24±3·1	(13) 29±2·2	(10) 19±1·4	(9) 20±2·4
	(13) 19±1·6 (*b*)				

Differences: No extract (*a*) and chloroform, 6·4 ± 4·3; no extract (*b*) and chloroform, 9·6 ± 2·8; no extract (*b*) and water, 5·4 ± 3·5. Control including one aberrant plant (*a*); control excluding this plant (*b*). Number of replicates in brackets

extract, which equals that of the intact grain series. This difference is not significant, but by omitting the aberrant plant (second row in Table 1) a highly significant difference is shown. The use of extracts in water, ethyl alcohol and ether produced negligible differences in flowering behaviour.

This result was inconclusive, but indicated the need for further investigation; the experiment was therefore repeated in 1952, using only chloroform as solvent. To ensure contact between the roots of the test embryos and the extract, the fatty material was deposited on fine angular sand while the chloroform was being removed by evaporation under reduced pressure. A fixed volume of the sand holding the amount of extract required was moistened with sterile water and added to the surface of the agar slopes on which the test embryos were grown. Care was taken to avoid fungal contamination, which occurred in less than 1 per cent of the cultures. After six days at 15° C. the embryos were planted out in sand culture. The 'scores' are given in Table 2: the concentration of the extracts is given in terms of the number of vernalized embryos in the extract presented to each test embryo. As additional control a series with extract of unvernalized embryos was added.

Table 2

	Extract from varying numbers of vernalized embryos				Extract from unvernalized embryos
	10	4	2	0	10
Excised embryos	(18) 29±1·8	(15) 21±1·9	(21) 24±1·7	(21) 24±1·7	(14) 22±2·0
Whole grain	(24) 28±1·5			(23) 29±1·5	

Differences: Extracts from vernalized and unvernalized embryos, 6·9 ± 2·7; extracts from vernalized embryos and no extract, 5·3 ±2·4; extracts from 10 and 2 embryos, 5·6 ± 2·4. Number of replicates in brackets

Here the effect of using *vernalized* embryos for the extract is highly significant, and the possible effect of the chloroform or of the other normal constituent of the embryos is eliminated. Lower concentrations were without effect. The acceleration of flowering is small and not commensurate with the amount of vernalized material put into each culture. The effect on the unvernalized embryos is, however, equivalent to that of nearly three weeks of vernalization. This may be due to the limitations of the extraction technique enumerated above, or it may be that the active substance is not identical with that produced by the complete vernalization reaction. It would be premature to speculate on this result in terms of the substances postulated in our hypothetical scheme for the vernalization reaction[8].

[1] Bonner, J., and Bonner, D., *Bot. Gaz.*, **110**, 154 (1948).
[2] Loehwing, W. F., *Science*, **107**, 529 (1948).
[3] Behrens, G., *Biol. Zentr.*, **68**, 1 (1949).
[4] Sironval, C., *Mem. Acad. Roy. Belg., Classe des Sciences*, **24**, 1 (1951)
[5] Roberts, R. H., "Plant Growth Substances", p. 347 (F. Skoog, Univ. of Wisconsin Press, Madison, Wis., 1951).
[6] Melchers, G., and Lang, A., *Biol. Zentr.*, **61**, 16 (1941).
[7] Purvis, O. N., *Ann. Bot.*, N.S., **8**, 285 (1944).
[8] Purvis, O. N., and Gregory, F. G., *Ann. Bot.*, N.S., **16**, 1 (1952).

CHEMICAL DOSIMETRY AT HIGH DOSE-RATES

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Chemical methods for the measurement of dosage of ionizing radiation have lately assumed increasing importance, and are now in wide use, particularly in studies of the radiation chemistry of aqueous media[1]. There has, however, been some doubt as to whether the methods so far proposed can be used successfully at high dose-rates of X- or γ-radiation such as are encountered, for example, close to kilocurie sources of γ-emitters.

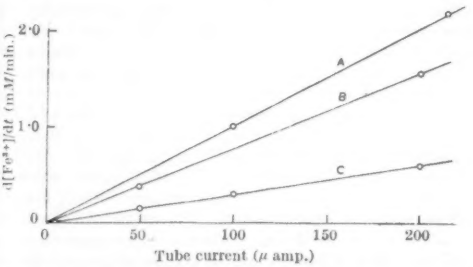
The method of radiation actinometry in most favour at present, the oxidation of ferrous ions in 0·8 *N* sulphuric acid solution, suffers from the disadvantage that the solution must remain effectively oxygen-saturated at all times for reproducible results to be secured, while the oxygen originally present in a solution in equilibrium with the atmosphere at room temperature is used up after a dose of about 50,000 r. has been administered[2]. At the dose-rates envisaged, this will happen in a matter of seconds. Moreover, at these high dose-rates there will not be time for the oxygen concentration within a solution to equalize itself by diffusion processes, so that if the release of energy within a given volume of solution is inhomogeneous, the elements of volume receiving the highest dose-rates will become deaerated before the remainder, with a consequent lowering of the overall yield before the solution as a whole has received an integral dose of 50,000 r.

These considerations have carefully to be borne in mind in any extension of the existing work on ferrous sulphate actinometry to high dose-rates, and it is apparent that in such studies means must be provided for starting and stopping the radiation virtually instantaneously, so that irradiation times of the order of seconds can be accurately measured.

Such facilities were recently made available to me by the Radiation Chemistry Group at the Atomic Energy Research Establishment, Harwell. Mr. John Milne, of this Group, designed and installed a magnetically operated device within the extension to the accelerator tube of the 2-million volt Van de Graaff generator, whereby a water-filled cell 9/16 in. deep, through which water was allowed to flow continuously, having a 1/16-in. aluminium window facing the electron beam, could be put into or withdrawn from the beam at a position 35 in. above the normal 1-mm. gold target by means of a switch operated at the control desk. The insertion of this cell cut down the X-ray intensity at the irradiation position just below the normal target by a factor of approximately 300.

By means of an auxiliary electric circuit, the beam current could be measured while the beam was impinging on the water target, and then adjusted to the desired value before the irradiation commenced. Corrections for the dose received during the preliminary build-up of tube current and voltage were made when necessary, but amounted to only about 1·5 per cent for an irradiation time of 15 sec.

Using this device, with irradiation times down to 10 sec., I have been able to show that the yield for the oxidation of ferrous ions in aerated 0·8 *N* sulphuric acid solution is independent of dose-rate up to the highest dose-rate obtainable from the machine, namely, approximately 100,000 r./min. The basis of the method is to study the rate of oxidation of ferrous ions in a 'Pyrex' cell of 2·8 cm. internal diameter and 8 mm. depth, totally filled with solution, as a function of the tube current in the machine at constant voltage. The dose-rate obtained from the machine was found, using a Baldwin 'Ionex' meter along the axis of the X-ray field, to be strictly proportionate to the tube current at constant voltage, while lateral surveys of the beam with the same meter showed that the geometrical distribution of dose-rate within the beam was not appreciably different at widely differing tube currents. The existence of a strictly linear relationship between the rate of oxidation of ferrous ions and the tube current was established at voltages of 1·5, 2·0 and 2·25 MV. (see graph), and with tube currents of 5–200 μ amp. Each of the points in the graph represents the average value obtained from at least four separate irradiations carried out under each set of conditions. At a tube current of 5 μ amp. and a voltage of 1·5 MV., the average dose-rate in this system corresponded to about 800 r./min.



Initial rate of increase of ferric ion concentration in aerated 0·8 *N* sulphuric acid solution as a function of the tube current in the Van de Graaff generator when run at 2·25 MV. (curve *A*), 2·0 MV. (curve *B*), and 1·5 MV. (curve *C*)

Similar studies have now been made by Ebert[3], using electron beams from the Van de Graaff generator at the Radiotherapeutic Research Centre, Hammersmith Hospital, London, who has found the initial yield for ferric ion production unaffected by dose-rate up to 3 million rep./min.; while Allen[4] reported similar results in the region 100–10,000 r./min. using X-ray beams from the 2-MV. generator at the Brookhaven Laboratory, New York.

In order to provide a further check on the absolute chemical yield at 800 r./min., experiments similar to those carried out previously[1] using the same machine were conducted. In these a cylindrical 'Perspex' irradiation cell of internal dimensions 30 mm. diameter and 3 mm. thickness, and 'Perspex' front wall thickness 6·4 mm., which could be regarded as effectively water-wall, was fixed at a position 18·5 cm. below the target, where the release of energy varied by no more than 8 per cent at all positions within the irradiated solution. The chemical change was compared with the integral dose within the solution by measuring the local dose-rate at many positions within the irradiated volume and carrying out appropriate integrations. As the Baldwin 'Ionex' meter used had been calibrated against an N.P.L.-standardized chamber to within ± 3 per cent, it was felt that this method was as accurate as any available. To ensure the presence during the ionization measurements of an electron atmosphere closely similar to that prevailing within the solution during the irradiations, the 'Ionex' meter was placed behind a 'Perspex' sheet of 6·4 mm. thickness; and the necessary small correction (< 0·3 per cent) for the absorption of the primary radiation within the solution was made using further data acquired with 'Perspex' absorbers of thickness from 3 to 13 mm. A value of the quantity *G* (ferric ions produced per 100 eV. expended in the solution) of 20·3 ± 1·0 was obtained, in further confirmation of my earlier work[1,2] and that of Hardwick[5], and Rigg, Stein and Weiss[6]. Values close to this have since been obtained by Ebert and Boag[3], and by Magat and Shapiro[7], and a figure of about 20 is now favoured by a great preponderance of evidence over that of 15·5 ± 0·3 obtained by Hochanadel and Ghormley[8]. The evident, if somewhat surprising, absence of any effect of dose-rate, or of any other source of irreproducibility so far detected in the system[1], signifies that the conditions were comparable in the various cases, and the reason for this discrepancy has still not come to light.

Similar studies were made using ceric sulphate solutions, which have the advantage of giving a yield independent of oxygen concentration[9], and the absolute *G* value for this reaction was estimated, by comparison with that for ferrous oxidation, as 3·0 at 59,500 r./min., in fair agreement with the figures of Hardwick[9] (3·2) and Milling, Stein and Weiss[10] (3·6), obtained at lower dose-rates. I am not entirely satisfied, however, as to the reproducibility of the behaviour of this system, as stated in an earlier publication[1]. Direct spectrophotometric analysis was used for both ferric and ceric ions, corrections being made for the variation of the extinction coefficient of ferric ion with temperature. The conditions for preparation of the solutions were identical with those described in my previous publications[1,2], with the exception that the water used was triply-distilled in an all-silica system.

Whereas the production of cerous ion was found to be proportional to dose up to 300,000 r. at 59,500 r./min., studies of ferrous oxidation at a dose-rate of 71,500 r./min. showed that the break in the oxidation – time plot at the point of oxygen depletion, which is normally observed to be sharp at low dose-rates[2], had become diffuse, signifying that conditions such as those described in the second paragraph of this communication had become operative. These conditions may partly explain the anomalously low yield obtained by me[2] and by Hardwick[11] using a General Electric 2-million volt X-ray unit; but doubtless the pulsed nature of the radiation in this case must, as Hardwick points out[11], also be taken into account.

Summarizing, it appears probable that chemical methods of dosimetry may be used for measuring continuous fluxes of X- or γ-rays up to the highest dose-rates at present envisaged.

Further experimental details of this work are included in an unclassified report from the Atomic Energy Research Establishment now in the press.

I am indebted to the Ministry of Supply for the tenure of a consultancy during which this work was carried out, to Dr. W. Wild and the members of the Radiation Chemistry Group at the Atomic Energy Research Establishment, Harwell, for the hospitality of their laboratories, and to Dr. F. T. Farmer and Mr. M. J. Day for a useful discussion on the accuracy of the physical measurements. Permission by Sir John Cockcroft to publish this communication is gratefully acknowledged. [Nov. 21.

[1] Miller and Wilkinson, Discuss. Farad. Soc., **12**, 50 (1952).
[2] Miller, *J. Chem. Phys.*, **18**, 79 (1950).
[3] Private communication (October 1952).
[4] Allen, Discuss. Farad. Soc., **12**, 114 (1952).
[5] Hardwick, *Canad. J. Chem.*, **30**, 17 (1952).
[6] Rigg, Stein and Weiss, *Proc. Roy. Soc.*, A, **211**, 375 (1952).
[7] Magat and Shapiro, Discuss. Farad. Soc., **12**, 130 (1952), and private communications.
[8] Hochanadel and Ghormley, Report No. BNL-171, U.S. Atomic Energy Commission.
[9] Hardwick, *Canad. J. Chem.*, **30**, 23 (1952).
[10] Milling, Stein and Weiss (cf. ref. 1).
[11] Hardwick, Discuss. Farad. Soc., **12**, 203 (1952).

REDUCTION OF FERRIC ION IN AQUEOUS SOLUTION BY γ-RADIATION

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ALTHOUGH the oxidation of dilute aqueous solutions of ferrous ion by ionizing radiation is a well-established fact, there is still some doubt concerning the reduction of ferric ion[1]. We have found that at sufficiently low acidities reduction may be effected[2], and that a steady state is set up with respect to ferrous and ferric ions if one irradiates either ferrous or ferric solutions, the position of the steady state depending upon the *p*H in sulphuric acid solutions[3]. Since publication of the latter work, further irradiations, particularly of ferric solutions, confirm this view, and in addition indicate that the initial reduction yield at low acidity is quite high.

Cobalt γ-radiation was employed under conditions similar to those previously described[3]. In addition to analysis of ferrous ion as the *o*-phenanthroline complex, direct estimation of ferric ion by its absorption at 304 mμ has also been employed in some cases; the two methods gave identical results. In order to avoid errors due to post-irradiation reactions arising from the slowness of the ferrous ion plus hydrogen peroxide reaction at low ferrous concentrations, all solutions were stood at room temperature for at least one hour between irradiation and analysis. The time of standing was varied up to six hours without any change in ferrous or ferric concentration greater than that found after one hour, and irradiations were carried out in a completely random order; the fact that the curves obtained still showed that a state is ultimately reached where no further oxidation or reduction can be detected appears to indicate that a true steady state is attained. The irradiation of solutions of *p*H > 2·5 presents some difficulty, since the second hydrolysis of ferric ion to $Fe(OH)_2^+$ becomes appreciable; this frequently leads to loss of ferric ion from solution, either by precipitation on the walls as $Fe(OH)_3$ or by formation of colloidal solutions. This leads to a depletion in strength of the original ferric solutions, and sometimes of the solutions of both ions formed on oxidation. In general, we have found it possible to carry out the oxidation of ferrous solutions up to *p*H 3·8 without serious difficulty; but in the case of ferric solutions above *p*H 2·5 frequent difficulties arise. All runs in which formation of $Fe(OH)_3$ had obviously occurred, or where ferrous solutions of low acidity had undergone aerobic oxidation, were rejected. Ferric solutions were prepared by oxidizing a ferrous solution with a slight excess of hydrogen peroxide, after which the excess peroxide was destroyed by boiling and the solution suitably diluted.

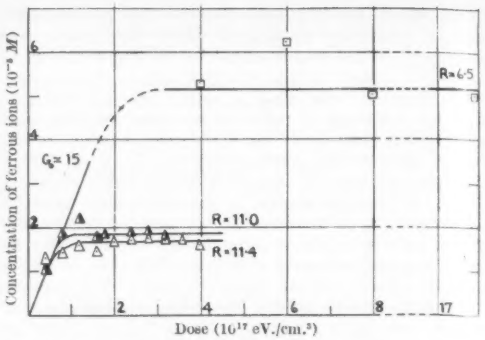

Fig. 1. Irradiation of ferric solutions in sulphuric acid in the presence of air, *p*H 2·46. ⊡, $[Fe^{3+}]_0 = 3{\cdot}86 \times 10^{-4}$ *M*; △, $[Fe^{3+}]_0 = 2{\cdot}11 \times 10^{-4}$ *M*; ▲, $[Fe^{3+}]_0 = 2{\cdot}23 \times 10^{-4}$ *M*

Fig. 1 shows the results obtained on irradiating three different ferric solutions in sulphuric acid, in the presence of air, at *p*H 2·46; the horizontal scale has been broken above 8×10^{17} eV./cm.^{3} in order to conserve space. Reduction occurs, with an initial yield (ions reduced per 100 eV.) of approximately 15; a steady state is set up with the values of R (ratio of ferric ion to ferrous ion) given on the curves. Fig. 2 shows the result of irradiating a solution containing approximately equal proportions of ferrous and ferric ions at the same *p*H. Oxidation occurs initially, and a steady state is attained when approximately 77 per cent of the total iron is in the ferric state.

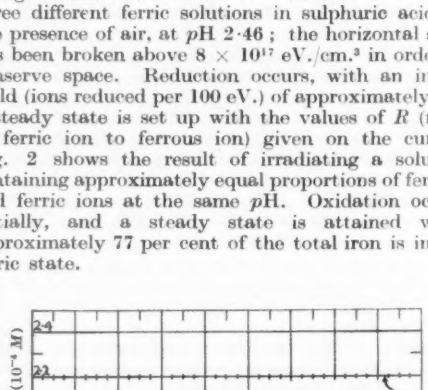

Fig. 2. Irradiation of solution containing both ferrous and ferric ions in sulphuric acid in the presence of air, *p*H 2·47. $[Fe^{2+}]_0 = 1{\cdot}05 \times 10^{-4}$ *M*; $[Fe^{3+}]_0 = 1{\cdot}15 \times 10^{-4}$ *M*

The initial reduction yield at this *p*H is comparable with the initial oxidation yield ($G_0 \sim 17$ [3]), but its measurement presents some difficulty, owing to the fact that the steady state is soon attained. With higher total iron concentrations the difficulties attendant upon hydrolysis are greater, but more precision should be attainable at a suitably lower dose-rate. The reduction of ferric ion in oxygen-free and in hydrogen-saturated solutions has been reported by Weiss and his co-workers[4], the yield increasing with increasing *p*H and being much greater in the case of hydrogen-saturated solutions. These yields were obtained at constant dose, and not from the initial slopes of reduction curves; a rough calculation based on the dose and concentration which they quote suggests that these single points probably correspond to steady-state values, so that their yields may be low. Haissinsky *et al.*[5] quote a value of $G_0 = 0{\cdot}07$ for the reduction by X-rays in $0{\cdot}8\ N$ sulphuric acid, but this is probably within the limits of experimental error; under these conditions the steady state corresponds to complete oxidation, or nearly so, and would be attained very rapidly on reduction.

In the ferrous–ferric system under the above conditions of *p*H, oxidation may be effected by hydroxyl radicals, hydroperoxide radicals (HO_2) and hydrogen peroxide, and reduction by hydrogen atoms and by O_2^- ions; the HO_2—O_2^- couple is expected to play an important part in the balance between oxidation and reduction[2,6,7], and the hydrolysis of ferric ion to $FeOH^{2+}$ must also be considered. Baxendale *et al.*[8] have given evidence to support the view that the *p*H-dependence in the $Fe^{2+} + H_2O_2$ reaction arises from a combination of the dissociation of hydroperoxide radicals with hydrolysis of ferric ions. In the irradiation reaction a further consequence of the hydrolysis is possible, namely, that the hydrogen atom reduction of ferric species may be more effective for the hydrolysed ions than for the aquo-ferric ion (or the sulphate complexes in strong solutions of sulphuric acid). Both the reactions:

$$Fe^{3+}_{aq.} + H_{aq.} \rightarrow Fe^{2+}_{aq.} + H^+_{aq.} \qquad (1)$$

and

$$\left.\begin{matrix} FeOH^{2+}_{aq.} \\ Fe^{3+}.OH^-_{aq.} \end{matrix}\right\} + H_{aq.} \rightarrow Fe^{2+}_{aq.} \qquad (2)$$

are quite exothermic[3], but (2) may be favoured by entropy considerations. In the first case, the completed hydration shell may act as a barrier to electron-transfer between the hydrogen atom and the central ion, whereas in (2) the reaction may effectively occur at the boundary of the shell, resulting in completion of the shell and attainment of a much more symmetrical configuration. The transfer of electrons between ferrous and ferric ions through the outer electronic orbits of hydroxyl ions has been postulated to explain the colours obtained when ferrous hydroxide precipitates are oxidized in air[9], and it is possible that a similar mechanism operates in (2) above to produce a net electron transfer from hydrogen to ferric ions. The calculation of the energetics of this step is made difficult by the fact that the reaction is assumed to occur within the complex, whereas most of the measured and calculated heats and entropies refer to the separation of the complexing ion from the central ion. The process may be written schematically as follows:

$$Fe^{3+}.OH^- + H \rightarrow [\overbrace{Fe\ldots}\ \overbrace{\ldots OH}\ \overbrace{\ldots H}]^{2+} \rightarrow Fe^{2+}.H_2O \quad (2a)$$

in which the other five co-ordinated water molecules are omitted, and the arrows indicate the direction of electron-flow.

Such a process may readily be envisaged in the absence of dissolved oxygen, and is, in fact, formally analogous to the back-reaction in the photo-induced reduction of water by ferrous ion[10]. It is usually assumed that, in the presence of oxygen, all the hydrogen atoms are removed by reaction (3):

$$H + O_2 \rightarrow HO_2. \qquad (3)$$

This appears to be beyond doubt at acidities greater than $0{\cdot}1\ N$, where the change from the oxygenated yield to the oxygen-free yield occurs at a point corresponding to the stoichiometry $\Delta[Fe^{2+}] = 4[O_2]$, without appreciable production of hydrogen. Although it is thus clear that (1) is negligible compared with (3), there is no evidence to suggest that similar considerations apply to (2) and (3) at higher *p*H. Owing to the more complex nature of the oxidation curve at higher *p*H, and to the changing value of the ratio of oxygenated to oxygen-free yield, such evidence would probably best be sought by measuring the consumption both of ferrous ions and of oxygen, as well as production of hydrogen, in an irradiation. It is suggested that, at sufficiently high *p*H, (2) may compete appreciably with (3); since the hydroperoxide radical can oxidize three ferrous ions, while O_2^- reduces only one ferric ion, there will be a net gain in reduction so far as the effect of the hydrogen atoms originally formed are concerned. The decrease in initial oxidation yield in the presence of excess ferric ion at high *p*H might be due in part to (2), which would then also be partly responsible for the fall in yield as oxidation proceeds. Competition between ferric species and dissolved oxygen for hydrogen atoms would not lead to a dependence of initial oxidation yield upon initial ferrous concentration, but to an initial reduction yield dependent upon initial ferric concentration.

It will be noted that the value of the ratio of ferric to ferrous ion obtained by oxidation of a ferrous solution ($R = 3{\cdot}3$) is appreciably less than that from reduction of a corresponding ferric solution ($R = 11{\cdot}2$), and that in the latter case the value appears to vary with initial ferric concentration; we believe that these differences lie outside the limits of experimental error. An inspection of earlier results (ref. 3, Table 3) shows a similar behaviour at *p*H 2·1, although here the difference is less. This appears to indicate that the steady state obtained on reduction differs from that produced by oxidation, that is, that the ferrous–ferric couple is not thermodynamically reversible with respect to hydrogen atoms and hydroxyl radicals; this would have important consequences for the concept of equivalent reduction potential[11]. The lower value of R obtained at higher initial ferric concentrations may be connected with the dependence upon concentration which would arise if reaction (2) is operative. [Aug. 20.

[1] Dewhurst, Farad. Soc. Discuss., April, 1952.
[2] Amphlett, *Nature*, **165**, 977 (1950).
[3] Amphlett, Farad. Soc. Discuss., April 1952.
[4] Rigg, Stein and Weiss, *Proc. Roy. Soc.*, A, **211**, 375 (1952).
[5] Haissinsky, Lefort and Lebail, *J. Chim. phys.*, **48**, 208 (1951).
[6] Evans, Hush and Uri, *Quart. Rev.*, **6**, 186 (1952).
[7] Uri, *Chem. Rev.*, **50**, 445 (1952).
[8] Barb, Baxendale, George and Hargrave, *Trans. Farad. Soc.*, **47**, 462 (1951).
[9] Shively and Weyl, *J. Phys. Coll. Chem.*, **55**, 512 (1951).
[10] Potterill, Walker and Weiss, *Proc. Roy. Soc.*, A, **156**, 561 (1936).
[11] Collinson and Dainton, Farad Soc. Discuss., April 1952.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Origin of the Solar Corona

If the distributions of electron density and temperature in the sun's atmosphere are known, thermal emission at any frequency in the radio spectrum may be calculated. Conversely, properties of the atmosphere may be deduced from the observed thermal emission spectrum[1]. In the range above 600 Mc./s. the observed level of radiation can be correlated with visible sunspot area. Excess radiation appearing with spots has been interpreted[2] as thermal emission from very hot (10^7 ° K. or more) high-pressure (perhaps a hundred times that of surrounding regions) regions above the sunspots. There is optical evidence[3] of similar regions, and the good agreement between theory and radio observations lends weight to the suggestion.

If these hot regions do exist, they are a likely source of at least some of the energy needed to maintain the corona. To investigate this possibility, a statistical analysis was made of measurements of solar radio noise at frequencies between 600 Mc./s. and 9,400 Mc./s. on most days over a period of several years. The total radiation was separated into two components—one appearing with sunspots (but not necessarily disappearing with them) and a residual or basic component. The intensities of the components were then used for determining corresponding volumes of gas at suitable temperatures and pressures. The results may be summarized as follows:

(1) The sunspot component diminishes less rapidly than the dying spots, and remains more than a month after the spots have vanished. Previous observational evidence of this effect in particular cases is available.

(2) Previous determinations of the basic component are too high. They were obtained[4] by plotting daily values of radio noise against sunspot area as in Figs. 1 and 2 for 600 Mc./s. where a basic component of about 5×10^5 ° K. is indicated. The persistence of radiation, as indicated above, results in many plots of high noise and very low area; for this and other reasons the basic component found is too high. The errors are corrected and correlation improved by using rotational mean values of noise and area, reducing the value to about $2{\cdot}8 \times 10^5$ ° K. If allowance for dead spots is made, as in Fig. 3, the value falls further to $1{\cdot}7 \times 10^5$ ° K. The corresponding reductions at 1,200 Mc./s. are even larger (by factors of 2·3 and 4·7 respectively). In the investigation, arithmetic rather than graphical methods were used, and care taken to avoid errors due to the statistical processes.

This result explains the reported large fall in the basic component during 1950[5] as merely a fall in the sunspot component due to a prolonged decrease of sunspot activity.

(3) These and earlier[2] results suggest that volumes of very hot high-pressure gas appear with sunspots, mainly (perhaps entirely) near the spots, and remain after the spots have vanished, spreading and merging with the surrounding cooler gases. During the period 1947–51, these gases at all times comprised most of the corona and were formed at a rate capable of completely replacing the average (Allen – van de Hulst) corona in a few days. They are suggested as the principal source of the corona.

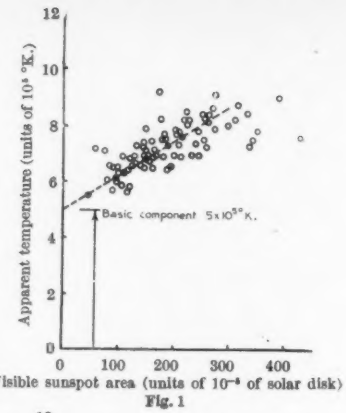

Fig. 1

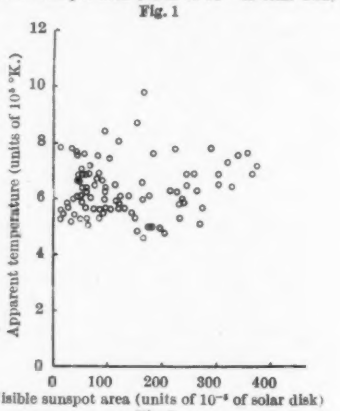

Fig. 2

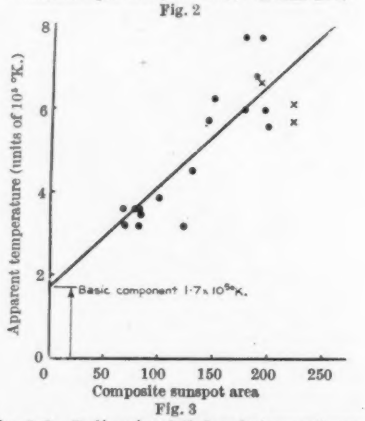

Fig. 3

Figs. 1–3. Radio noise plotted against sunspot area.
(1) Daily values for the period August–November 1947.
(2) Daily values for the period January–July 1950.
(3) Average value of radio noise for a given solar rotation plotted against a composite spot area $0{\cdot}4A_0 + 0{\cdot}3A_{-1} + 0{\cdot}2A_{-2} + 0{\cdot}1A_{-3}$, where A_{-n} is the average spot area n rotations earlier. The period concerned is December 1949–April 1951

It is estimated that if sunspots were entirely absent for some months and no other additional source of energy became available, the corona would diminish to one-tenth the extent, or one-third the electron density, observed during relatively quiet periods in 1948.

The results may provide a step towards an understanding of coronal heating and evidence against some existing theories, notably accretion theories[6]. Full details will be published elsewhere.

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Jan. 19.

[1] Piddington, J. H., *Proc. Roy. Soc.*, A, **203**, 417 (1950).
[2] Piddington, J. H., and Minnett, H. C., *Aust. J. Sci. Res.*, A **4**, 131 (1951).
[3] Waldmeier, M., *Astron. Mitt. Zurich*, No. 149 (1945).
[4] Pawsey, J. L., and Yabsley, D. E., *Aust. J. Sci. Res.*, **A2**, 198 (1949).
[5] Christiansen, W. N., and Hindman, J. V., *Nature*, **167**, 635 (1951).
[6] Bondi, H., Hoyle, F., and Lyttleton, R. A., *Mon. Not. Roy. Astro. Soc.*, **107**, 184 (1947).

Distances of the Magellanic Clouds

The distances of 26 and 23 kiloparsecs derived by Shapley[1] for the two Magellanic Clouds depend upon assuming the same absolute magnitudes for the Cepheid variables in the Clouds and in our own galaxy. The absolute magnitudes of the galactic Cepheids are still subject to considerable uncertainties, and it would be more satisfactory to use as distance-indicators the *RR* Lyræ variables (with periods less than 1 day) the absolute magnitudes of which are known more accurately and which are found in great abundance in our own galaxy. Very few such variables, however, have been found in the Small Cloud[2], and none so far has been reported in the Large Cloud.

A search for *RR* Lyræ variables in the Clouds was begun soon after the installation of the Radcliffe 74-in. reflector. *NGC* 1866, one of the largest and brightest clusters in the Large Cloud, was first selected as a region for investigation, but failed to reveal any variables of *RR* Lyræ type; instead, surprisingly enough, some classical Cepheids turned up[3]. It is now possible to report successful searches for *RR* Lyræ variables in three clusters as follows:

(1) Cluster	(2) Region	(3) No. of variables	(4) Short period	(5) m_{pg}	(6) Deduced distance (kpc.)
NGC 121	Edge of Small Cloud	4	3	18·6	44
NGC 1466	Edge of Large Cloud	28	21	18·7	44
NGC 1978	Within Large Cloud	4	2	18·7	42

NGC 121 lies within and *NGC* 1466 lies just outside the faint extension borders found by Shapley[4]. Column (3) gives the total number of variables so far found on Radcliffe plates apparently associated with these clusters; column (4) gives the number of variables so far shown to have short periods. Column (5) gives the mean apparent photographic magnitude of the stars in column (4) as derived from comparisons with the Selected Areas 68 and 94, at the same altitude. The comparisons are subject to uncertainties partly because of the large change in azimuth required, and partly because old magnitudes in Selected Area 94 had to be used. The deduced distances in column (6) depend on assuming $M_{pg} = 0$ for these variables, and on a correction for interstellar absorption amounting to 0·31 mag. cosec b, as given by Oort[5].

These newly discovered faint variables therefore indicate that the distances of the Magellanic Clouds are larger than believed hitherto. A precise redetermination must await revised magnitudes in Selected Area 94. The uncertainty in the distances given in column (6) must be of the order of 25 per cent, mostly arising from the difficulty of comparison with the Selected Areas, but partly also from the uncertainty in the assumed absolute magnitude of *RR* Lyræ variables. The indications are that an error in the comparison is likely to have underestimated the distances. The conclusion supports the results reported by Baade for the Andromeda nebula at the International Astronomical Union meeting in Rome, 1952.

The increased distance, which has been supported by Shapley[6], implies an increased luminosity for classical Cepheids and hence a change in the shape of the period–luminosity curve. Such a change in shape, especially at about $P = 1$ day, was already suggested by the variables in the Sculptor System[7], which showed a difference of about 1 magnitude between $P = 1$ day and $P = 0{\cdot}5$ day.

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Radcliffe Observatory,
Pretoria.
Feb. 18.

[1] Shapley, H., "Galaxies", 49, and *Proc. U.S. Nat. Acad. Sci.*, **26**, 326, 547 (1940).
[2] Dartayet, M., and Dessy, J. L., *Astrophys. J.*, **115**, 279 (1952).
[3] Quoted by Baade, W., *Michigan Obs. Pub.*, **10**, 13 (1951).
[4] Shapley, H., "Galaxies", 50, Fig. 28.
[5] Oort, J. H., *B.A.N.*, **208**, 237 (1938).
[6] Shapley, H., *Sky and Telescope*, **12**, 45 (1952).
[7] Thackeray, A. D., *Observatory*, **70**, 144 (1950).

Travelling Disturbances in the Ionosphere: Diurnal Variation of Direction

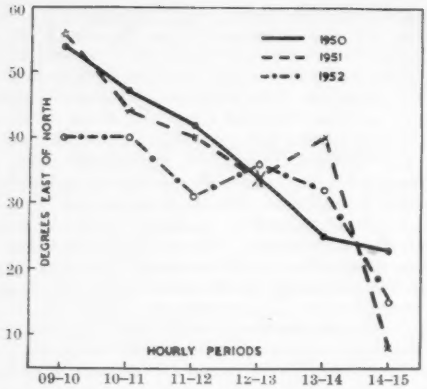
The detection of travelling disturbances in the *F*-region of the ionosphere has already been reported[1]. In the last-mentioned paper, it was stated (p. 221): "It has not yet been possible with the limited data available to detect any definite diurnal variation". This has been interpreted in some more recent publications by other authors as implying that there is no diurnal variation.

Since the publication of the original papers, more observations of greater accuracy and extending over a greater part of the day have provided definite evidence of diurnal variation in the direction of horizontal movement. This is most marked in the month of June. The accompanying graph shows the median values of all directions observed for each hourly interval for all days of June in each of the three years 1950–52. Each point is the median of the appropriate number of values listed in the table.

It will be seen that there is a similar trend in the three years, the direction of movement changing from approximately 50° (E. of N.) at 0930 to 15° at 1430. In addition, some recent night observations, though not sufficient for definite conclusions, suggest that there is consistently an east–west component of

Number of Independent Observations of Direction

	09h–10h	10h–11h	11h–12h	12h–13h	13h–14h	14h–15h
1950	2	15	28	44	30	14
1951	29	44	52	72	40	19
1952	39	70	74	81	41	27



Diurnal variation of direction of movement in June

movement present at night, in contrast with the consistently west–east component present in the daytime, indicating a significant change in direction of travel as between day and night. These observations are being extended, and the results and implications will be discussed more fully elsewhere.

This work has been carried out in the Electrical Engineering Department of the University of Sydney as part of the investigations of the Radio Research Board of the Commonwealth Scientific and Industrial Research Organization, and is published with the consent of the Executive. The invaluable assistance of the technical staff of the Radio Research Board is gratefully acknowledged.

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Oct. 21.

[1] *Nature*, **161**, 886 (1948); **162**, 812 (1949); *Proc. Roy. Soc.*, A, **202**, 208 (1950).

Beta-Spectrum of Radium E

The shape of the β-spectrum of radium E differs from the Fermi allowed form. It has been investigated thoroughly; but there are many effects which usually distort the spectrum in the low-energy region; for example, straggling and back-scattering in the source, electron scattering in the spectrometer, distortion introduced by the detector and many others.

Different ways of eliminating these disturbances have been tried lately; for example, Waltner and Rogers[1] observed the beta-tracks in a cloud chamber, Langer and his co-workers[2] used a windowless Geiger counter. Nevertheless, the results obtained by different authors showed marked discrepancies in the low-energy region.

We tried to solve the problem by preparing a very thin source and using electron-sensitive nuclear emulsions (Ilford *G5*) as a detector. The intensities were found by counting the β-tracks recorded in a magnetic lens spectrograph. In all, 35,000 tracks were counted. The shape of the spectrum was investigated down to 4·6 keV. Very thin sources were prepared by a volatilization method. They were suspended on a 'Zapon' film which was coated with an extremely thin layer of gold to increase the conductivity. The whole thickness of the source, 'Zapon' and gold was not greater than 4–4½ μgm./cm.². From an examination of images obtained in the spectrograph, it was found that the uniformity of the sources (1·1 mm. diameter) was satisfactory. The electron tracks were recorded on the surface of the emulsion, which therefore could be only 25 μ thick. During the processing of the emulsion, great care was taken to obtain a clear surface with reduced background grains. For the lowest energy the 'tracks' contained one grain only. In this region, elimination of the background was done by the measurement of the grain density in the vicinity of the spot. In some cases, for better separation of overlapping grains, the emulsion was resoaked in water before microscopic examination. Nuclear emulsions were used to focus the spectrograph and also in the investigation of the relation between the energy and the number of grains.

Analysis of the geometrical distribution of intensity in the images of the source at different energies showed that it was possible to take into account the tracks recorded in a wide zone of each image. It was shown that the measured intensities did not depend much on the position of counting area (zones).

Figs. 1 and 2 represent the results concerning the energy and momentum distribution in the radium E spectrum. The energy distribution curve probably cuts the $I(E)$ co-ordinate. From the experimental points it is evident that below 50 keV. the distribution function cannot be interpreted in terms of $(E-E_0)^4$.

Details of the method of preparation of source and the investigation of the relation between the number of grains and energy below 30 keV. will be given shortly in *Acta Physica Polonica*.

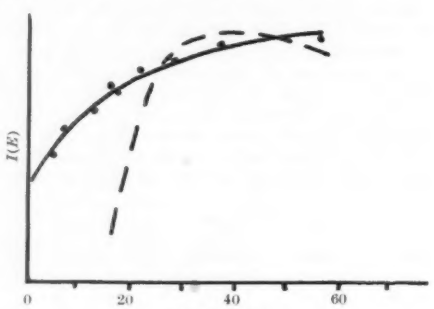

Fig. 1. — — —, Waltner and Rogers's results

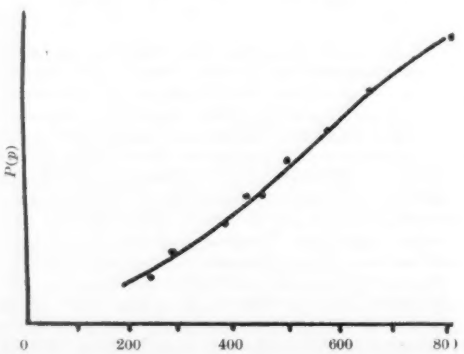

Fig. 2

This work was done in the George Holt Physics Laboratory, University of Liverpool, during 1949–50. We wish to express our gratitude to Profs. S. Pieńkowski, J. Rotblat and H. W. B. Skinner for their encouragement and interest. We are also indebted to Mr. D. G. E. Martin for help and many discussions.

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[1] Waltner, A., and Rogers, F. T., *Phys. Rev.*, **74**, 699 (1948); **75**, 1445 (1949).
[2] Langer, L. M., Motz, J. W., and Price, H. C., *Phys. Rev.*, **77**, 774, 798 (1950).

A Simple X-Ray Micro-beam Technique

A simple method has been devised to enable X-ray diffraction photographs to be obtained from a single plant cell the size of which is of the order of 10 μ × 10 μ × a few mm. long. Although details of methods using micro-focus tubes and micro-beams have been published, they are not suitable in this instance because of the low diffracting power of cellulosic materials.

Small lead-glass capillaries are not satisfactory because scatter from the edges of the aperture is great enough to obscure diffraction from the specimen. Using metal pin-holes, it is extremely difficult to make and adjust the necessary secondary aperture, so that satisfactory results are never obtained.

The system in use at present (Fig. 1) consists of two tilted metal plates mounted over the exit aperture of a collimator with two ½-mm. pin-holes 50 mm. apart. The geometry of the system is made such that the corners of the plates define the beam (30 μ wide) while the edges prevent scatter from these corners reaching the photographic film. Because long specimens are used and because we are only concerned with the equatorial arcs, only one pair of plates is used; however, a second pair mounted at right-angles to the first could be used if it became necessary either to use a square beam or to remove the meridional streak, or both. The large entrance aperture allows the whole of the X-ray source of normal dimensions to be used.

The specimen is mounted directly on the collimator; to ensure that it will be in the X-ray beam, light is passed through the whole collimator and the specimen adjusted, under a binocular microscope, to be in the light beam. The collimator carrying the specimen is then transferred to a normal flat-film camera. A Geiger counter and rate-meter are essential for lining up the collimator with the X-ray source.

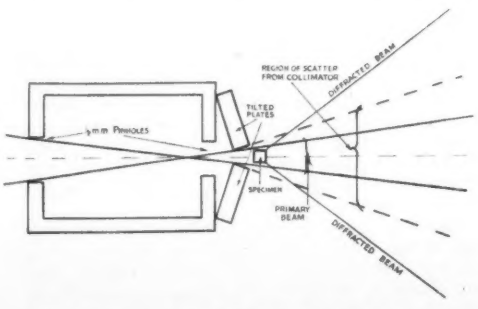

Fig. 1. Diagrammatic section of collimating system

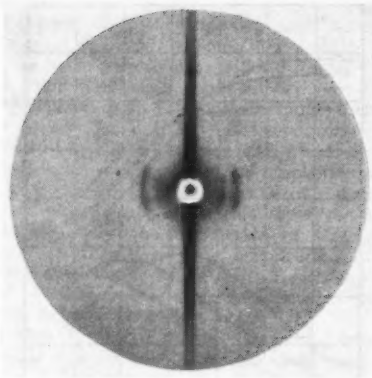

Fig. 2. X-ray photograph from a single sisal cell. Film to specimen, 17 mm.; beam, 30 μ × 400 μ; unfiltered copper *K* radiation; exposed 100 hr. on Hilger *HRX* unit operating at about 35 m.amp. and 40 kV.

Fig. 2 illustrates the type of photograph given by a single cell of sisal using this method.

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Resonance Absorption in Liquid Methyl Palmitate and Methyl Stearate in the Microwave Region

In a previous communication in *Nature*[1], it was pointed out that dielectric measurements on solid methyl palmitate, in the microwave region, showed features which were difficult to explain on the basis of a purely relaxation type of loss, and it was suggested that resonance absorption was occurring at some frequency in this region. This conclusion was criticized[2], and it must be admitted that the evidence was not entirely convincing.

Measurements have since been made on stearic and palmitic acids and their methyl and ethyl esters at temperatures ranging from the melting points to about 30 or 40 deg. C. above the melting points. The measurements at 3·2 cm. and 1·26 cm. were obtained by the Roberts – von Hippel method, and the measurements at the other wave-lengths, 17, 10, 9, 8, 6·5, 5, 4·5 and 4 cm., were obtained by a phase and amplitude balance method using coaxial-line equipment. This method is a development of one described by me elsewhere[3] and is similar to that described by Branin and Smyth[4]. The wave-lengths 5, 4·5 and 4 cm. were obtained by harmonic generation.

The acids show a fairly small loss in the microwave region, with a suggestion of a small relaxation loss near 3 cm. wave-length. The loss in the methyl and ethyl esters was much greater than in the acids. The curves of ε' and ε'' as functions of frequency are, in the case of the ethyl esters, normal relaxation loss curves with a spread of relaxation times. The measurements on ethyl palmitate are shown in Fig. 1. Ethyl stearate gives similar curves. The results for

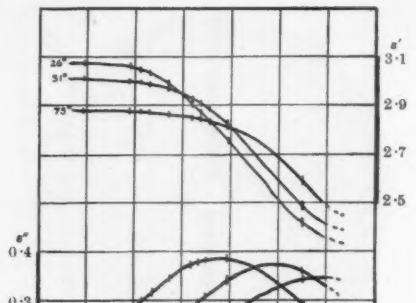

Fig. 1. Ethyl palmitate

methyl palmitate are shown in Fig. 2, and there is a decided irregularity in the ε' curve and a fairly pronounced shoulder in the ε'' curve. These irregularities occur at about 6,000 Mc./s., and this frequency shows little or no change with temperature; but the irregularities diminish as the temperature rises and the curves then tend to become normal relaxation curves with a spread of relaxation times. The curves for methyl stearate are similar to the palmitate curves.

The dotted curves in Fig. 2 indicate the values of ε' and ε'' which would be expected from a purely relaxation process. If we plot the difference between the dotted curves and the experimental curves, we obtain the curves P and Q, which are very suggestive of a resonance absorption. There is some latitude in the choice of the dotted curves; but any reasonable choice will lead to curves which will not differ very much, in shape, from P and Q.

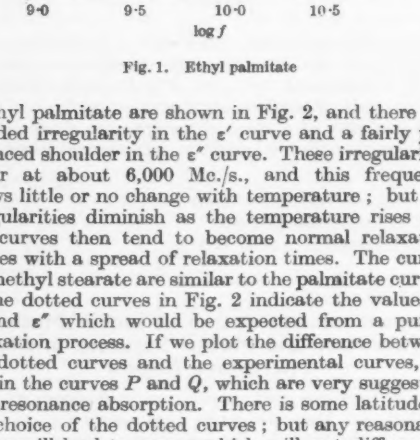

Fig. 2. Methyl palmitate

The central frequency of this resonance absorption is approximately 6,000 Mc./s. and is, within experimental error, the same frequency as obtained with methyl stearate. This frequency is 100–1,000 times smaller than the resonance frequency which one would expect for the type of resonance absorption discussed by Frohlich[5]. Rotation of the molecule around the long axis would give a frequency of the right order of magnitude when allowance is made for the effect of the retarding potential barriers[6].

The resonance absorption decreases and finally vanishes at temperatures about 40 deg. C. above the melting point. It is well known that many long-chain compounds show a state of short-range order in which the molecules tend to lie parallel to each other. This condition is most in evidence near the melting point, and the order diminishes as the temperature rises. It seems likely that this short-range order is necessary for the existence of this form of resonance absorption. If this absorption is due to rotation of the molecules around the long axis, then this can be understood. When the temperature rises and the molecules begin to twist and crumple about the C—C bonds[7], then rotation around the long axis would not occur.

It is a little surprising that the ethyl esters do not show the same effect as the methyl esters, though the ethyl group, being larger than the methyl group, probably projects farther from the axis of the molecule and may give rise to a steric hindrance to rotation.

Thanks are due to Prof. J. E. Roberts for his interest in this work and for the facilities provided; and also to Messrs. Unilever, Ltd., for providing pure specimens of the acids and the methyl esters.

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[1] Cook, H. F., and Buchanan, T. J., *Nature*, **165**, 358 (1950).
[2] Dryden, J. S., and Welsh, H. K., *Aust. J. Sci. Res.*, **4**, 616 (1951). Hoffman, J. D., *J. Chem. Phys.*, **20**, 541 (1952). Higasi, K., and Ozawa, Y., *J. Phys. Soc. Japan*, **6**, 280 (1951).
[3] Buchanan, T. J., *Proc. Inst. Elect. Eng.*, Pt. III, **99**, 61 (1952).
[4] Branin, F. H., and Smyth, C. P., *J. Chem. Phys.*, **20**, 1121 (1952).
[5] Frohlich, H., "Theory of Dielectrics" (Oxf. Univ. Press, 1949).
[6] Pauling, L., *Phys. Rev.*, **36**, 430 (1930).
[7] Ubbelohde, A. R., and McCoubrey, J. C., Farad. Soc. Discuss. on Hydrocarbons, 91.

An X-Ray Diffraction Study of the Transformation of Retained Austenite by Fracture

During an investigation of the structure of a hardened 1½ per cent chromium steel, the presence of a small amount of retained austenite was observed in the microstructure. Examination of this material by the glancing-angle X-ray diffraction technique revealed retained austenite on a surface mechanically polished and etched for micro-examination, whereas retained austenite could not be found on the surface of a fracture produced by fatigue, or on a freshly produced brittle fracture surface.

That the austenite was introduced during preparation of the microspecimen seemed unlikely owing to precautions taken to avoid overheating in grinding and polishing and from the appearance of the microstructure. This hypothesis was finally disproved by

further X-ray pictures showing the presence of retained austenite: (1) on a small flat prepared on a brittle fracture by lightly hand-polishing to a depth of several thousandths of an inch below the fracture surface; (2) on both types of fracture after removing metal from the fracture surface by deep-etching, the largest proportion of retained austenite being observed for the deepest etch.

It would appear impossible to interpret the evidence except by assuming a complete (within the experimental accuracy) transformation of retained austenite at fracture surfaces, presumably as a result of highly localized shear deformation at the position of fracture.

B. L. Averbach, S. G. Lorris and M. Cohen, in their paper on "Stress-Induced Transformation of Retained Austenite in Hardened Steel"[1], have also observed that retained austenite contained in a specimen of hardened 3½ per cent nickel steel transforms completely at a fracture, and, incidentally, that an inverse relation appears to exist between strain and the amount of retained austenite remaining. We do not know of any reference to this phenomenon occurring in a 1½ per cent chromium steel. It is considered likely that other types of hardenable steel which contain retained austenite after hardening will exhibit a similar transformation.

These examples of the complete transformation of retained austenite on fracture surfaces are of particular importance to the X-ray crystallographer in that they throw doubt on the validity of the usual contention that newly fractured surfaces are most suitable for X-ray diffraction tests on bulk metal specimens. Grinding, polishing, etching, electropolishing, machining and filing are all well known to introduce specific dangers of possible errors of interpretation. Our observations indicate that even freshly broken surfaces may show a structure or texture which is not typical of the bulk material. It is imperative that the crystallographer should consider sample preparations most carefully and treat every particular experiment on its merits.

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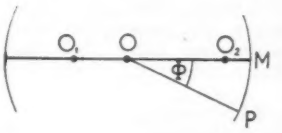
[1] Averbach, B. L., Lorris, S. G., and Cohen, M., *Trans. Amer. Soc. Met.*, **44**, 746 (1952).

A New Method of Light Microscopy

The method described by Prof. A. Wilska[1] appears to be a special case of phase-contrast, generally known as 'amplitude-contrast'. Although not usually employed with fixed phase-contrast objectives, it frequently crops up in variable phase-contrast and interference systems. Oettlé[2], for example, used it in his experiments with a variable amplitude and phase microscope. The basic theory can be simply explained by a vector treatment similar to that given in detail elsewhere[3]. Object details can be represented by points in or on the well-known vector circle, centre O, radius OM. In conventional microscopy, the origin remains at O and transparent phase-changing details such as P, which lie on the circumference of the circle, are all equidistant from O and appear with equal intensity, OP^2 ($= OM^2$), so that contrast is zero.

The object of phase-contrast and interference microscopy is to shift O to some new position so that points on the circumference will no longer be equidistant from the origin, but will appear with intensities depending on φ, the phase change introduced by the detail. In ordinary phase-contrast this is achieved by rotating the vector OM, which represents the direct light, and changing its amplitude, that is, by altering the phase and intensity of the direct or diffracted components. We can, however, shift O by changing only the amplitude of OM without rotation. In this case pure amplitude-contrast is obtained and the new origin lies somewhere on OM. In Prof. Wilska's second method, the intensity of the direct light is reduced to about 1/12. The amplitude is thus $1/\sqrt{12}$ or 0·29. The new origin is O_2, where $O_2M = 0{\cdot}29$, OM being taken as unity. The background intensity is now O_2M^2, the detail intensity O_2P^2. Thus for all except very small phase changes, the image detail will be brighter than the background and it will not be possible to distinguish phase advances from phase retardations. If all the direct light were absorbed, the new origin would coincide with M, giving central dark-ground illumination in which theoretically all details will be bright on a black background.

In his first method, Prof. Wilska absorbs 50 per cent of the diffracted light. In this case the new origin will be at O_1, where $O_1M = \sqrt{2}$. This is an example of B-type amplitude contrast[2,4]. The detail intensity O_1P^2 is now always less than the background intensity O_1M^2, so that dark contrast occurs. However, for small phase changes, O_1P is very nearly equal to O_1M, so that contrast is inherently poor, and becomes worse as the transmission of the diffracted light decreases, that is, as O_1 moves farther away from M. This latter method is therefore only useful for rather refractile objects such as thick cells and fibres.



The halo effect[5] is inherent in all phase-contrast and interference systems in which there is incomplete separation of the interfering beams (in this case the direct and diffracted components). It becomes much more conspicuous with heavy absorption of the direct light and is particularly noticeable in Prof. Wilska's photographs, for example, around the sperm tail in Fig. (*c*) and the edge of the epithelial cell in Fig. (*e*). The halo will be much less obvious in B-type contrast as observed by Prof. Wilska, and it will also depend on the width of the annular ring in the objective, which determines the degree of overlap between direct and diffracted light.

These considerations are based on the assumption that it is possible to affect the transmission of the light wave without altering its phase. If the partly absorbing layer introduces a phase change, then some degree of phase-contrast will occur and O_1 and O_2 will no longer lie on OM. In Prof. Wilska's first method the phase of the direct light will be advanced, and in the second case it will be retarded, relative to the diffracted light. This will give rise to positive and negative phase-contrast respectively, thus heightening the effects already predicted.

Prof. Wilska's letter should be useful in directing the attention of microscopists to the value of amplitude-contrast and central dark-ground illumination in some cases. His photographs show that excellent results can be obtained by very simple means.

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[1] Wilska, A., *Nature*, **171**, 353 (1953).
[2] Oettlé, A. G., *J. Roy. Micr. Soc.*, **70**, 232, 255 (1950).
[3] Barer, in "Contraste de Phase et Contraste par Interférences" (Paris: *Revue d'Optique*, 1952); *J. Roy. Micr. Soc.*, **72**, 10, 81 (1952); and in the press.
[4] Bennett, A. H., Osterberg, H., Jupnik, H., and Richards, O. W., "Phase Microscopy" (Wiley, New York, 1951).
[5] Zernike, F., *Physica*, **9**, 686, 974 (1942).

Without criticizing the vector treatment of amplitude and phase-contrast microscopy kindly given by Dr. Barer in his comment on my letter[1], I would like to make the following comments: (1) Using my second method, phase-advancing objects appear darker than the background. The soot layer appears to cause a considerable phase retardation in addition to the absorption. (2) If the absorbing annulus is made substantially darker, the resulting image becomes peculiarly glossy and too unsharp to be of any value. Thus the "central dark-ground illumination" does not seem to be very promising in this connexion. (3) According to Oettlé[2], as well as from my own observations, ordinary negative phase-contrast methods do not produce images comparable with those of positive phase-contrast in clarity. The inherent haziness and glare of the negative phase-contrast picture may be due entirely to the light reflected from the phase plate and converged back to the area under observation. Due to the reflectivity of absorbing annuli evaporated by ordinary means, this additional surface illumination may reach higher values than the light passing the objective annulus. My method does not suffer from this in the same degree since the reflectivity of soot is small.

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[1] Wilska, A., *Nature*, **171**, 353 (1953).
[2] Oettlé, A. G., *J. Roy. Micr. Soc.*, **70**, 232 (1950).

Ability to smell Solutions of Potassium Cyanide

It has been known for many years that some individuals are unable to smell hydrogen cyanide, and the possibility that this inability may be genetically controlled was mentioned at a recent conference on the origin and evolution of man[1]. A short time ago our attention was directed again to this phenomenon, and we have since used a simple method of ascertaining the frequency of the inability to smell hydrogen cyanide among the white population of Australia and carried out a preliminary study of the mode of inheritance of this character.

The sample of the adult population comprised 244 individuals ranging in age from sixteen to sixty. The method of testing finally adopted consisted of presenting alternately tubes containing respectively 5 ml. distilled water and 5 ml. 20 per cent potassium cyanide soaked into cotton-wool. The tubes were stoppered between tests. Fresh tubes were made up at the beginning of each day. Subjects were asked to state if they could smell anything in either tube. Those that could were classified for the strength of their response on a subjective five-point scale. Independent observers achieved similar results using this method. Subjects whose response was doubtful or negative were retested after a rest of several minutes. Non-smeller individuals were retested in nearly all cases on subsequent days.

There is a striking difference between the sexes in the incidence of non-smellers when this method of testing is used, 24 out of 132 males, and 5 out of 112 females being unable to distinguish the cyanide tube from that containing distilled water. Of the remaining individuals tested, 31 males and 26 females could distinguish the smell from the potassium cyanide tube only faintly, but all were able to pick out the correct tube when retested. All the other subjects could distinctly and immediately recognize a smell in the tube containing the cyanide, though the nature and strength of the response varied considerably from person to person. The proportion of non-smeller males and females suggests that the inability to smell is a sex-linked recessive. The observed frequency of females (4·46 per cent) corresponds closely with what would be expected (3·33 per cent) from the observed number of males (18·2 per cent) if sex-linkage were operating. The difference between the frequency of the recessive gene calculated from the number of non-smeller males and that calculated from the number of non-smeller females does not differ significantly from zero when tested by the method of Snyder[2].

In an attempt to examine further the possibility of sex linkage, we have tested 61 families containing two or more children older than ten years. The 122 parents of these children are included in the larger sample of 244 individuals discussed above. Table 1 gives the number of smellers and non-smellers among the offspring in various mating groups.

Table 1

Group	No. of families	Parents		Children			
		Males	Females	Male		Female	
				S.	N.S.	S.	N.S.
1	45	Smeller	Smeller (expected)	53 (48)	4 (9)	54 (54)	0 (0)
2	12	Non-smeller	Smeller (expected)	11 (11)	2 (2)	13 (13)	3 (3)
3	4	Smeller	Non-smeller (expected)	2 (0)	2 (4)	4 (4)	0 (0)
4	0	Non-smeller	Non-smeller	—	—	—	—
Total	61			66	8	71	3

Though the number of families tested so far does not enable a decisive answer to be given by gene frequency analysis, the results indicate that a sex-linked recessive gene is possibly involved in the control of the ability to smell hydrogen cyanide. There is a deficiency of non-smeller males in group 1 and there are two exceptions in group 3. In this latter group all male children should be non-smellers. One of these children is a very doubtful smeller, but the other has no difficulty in detecting the presence of cyanide. One explanation of such discrepancies may be the operation of other genetic factors which

Table 2

No. of families	Parents		Children			
	Males	Females	Weak ♂	Weak ♀	Strong ♂	Strong ♀
10	Strong	Strong	2	2	9	10
9	Weak	Strong	4	4	5	6
14	Strong	Weak	9	10	9	6
12	Weak	Weak	11	11	4	5
Total 45			26	27	27	27

affect the degree of manifestation of the smeller characteristic. We have demonstrated that other factors are involved for people who are classified as smellers by grouping individuals into 'weak' and 'strong' categories. Table 2 gives the distribution of 'weak' and 'strong' smellers among the 45 families in group 1.

There is no difference between the sexes for the strength of response of individuals who are smellers; but there is a highly significant tendency for parents who are 'strong' smellers to have children who are 'strong' smellers, and parents who are 'weak' smellers to have children who are 'weak' smellers ($\chi^2 = 16{\cdot}173$ with 3 degrees of freedom; $0{\cdot}001 < P < 0{\cdot}01$).

Any hypothesis which seeks to explain the inability to smell solutions containing potassium cyanide in terms of a sex-linked recessive gene must take into account, therefore, the possibility that some smeller individuals may be wrongly classified because of the intervention of other genetic factors affecting the strength of the response.

A fuller account of this work will be published elsewhere.

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[1] Mourant, A. E., Cold Spring Harbor Symp. Quant. Biol., **15**, 242 (1950).
[2] Snyder, L. H., *Genetics*, **19**, 1 (1934).

Serum Iron and Iron-binding Capacity in the South African Bantu

Excessive amounts of iron are frequently present in various organs and tissues of adult South African Bantu[1]. Among these people, the iron intake is often high, as much as 200 mgm. per diem[2]. Further, occasional high values for serum iron have been reported among the Bantu of Bechuanaland[3]. In view of these facts, serum iron-levels, iron-binding capacity and other data have been determined in groups of adult Bantu from different regions of Southern Africa.

The Johannesburg group, of ages up to sixty years, were from a local non-European hospital; they were either on the staff or were suffering from complaints unlikely to influence levels of serum iron or iron-binding capacity. The Bantu males, 18–40 years, were workers from different territories, passed as medically fit for service in the gold mines. The European controls were members of the staff of this Institute.

Means, Standard Deviations and Ranges of Serum Iron and Total Iron-binding Capacity in Different Bantu Groups

	Remarks	Serum iron (γ per 100 ml.)	Total iron-binding capacity (γ per 100 ml.)
Bantu females	Johannesburg area	130 ± 40 (20)* (60–215)	335 ± 55 (17)* (240–435)
Bantu males	Johannesburg area	230 ± 75 (14) (110–380)	385 ± 50 (14) (320–475)
	Group A†	105 ± 45 (39) (15–225)	375 ± 70 (39) (225–590)
	Group B‡	285 ± 100 (68) (110–550)	520 ± 90 (42) (395–830)

* Number of subjects.
† Bantu with serum iron and total iron-binding capacity within normal range; Pondoland (13), N. Transvaal (Bapedi) (14), Tanganyika (12).
‡ Bantu with increased serum iron and total iron-binding capacity, significantly higher than those of group A; Mozambique (44), Angola (12), Nyasaland (12).

Samples were taken by venipuncture between 9.30 and 11.30 a.m., the usual precautions being taken to prevent contamination with iron. Serum iron was determined using the thioglycollic acid method. The iron-binding capacity was determined by the method of Rath and Finch[4]. The total iron-binding capacity was obtained by adding the value for serum iron to the iron-binding capacity. The difference between duplicates was never more than 10 per cent; all figures, therefore, including means and standard deviations, are given to the nearest 5 γ.

Our results for control groups of Europeans were in close agreement with values reported by other workers[4,5].

Several of the individual values obtained for serum iron and total iron-binding capacity were higher than any reported for such diseases as idiopathic hæmochromatosis or transfusional siderosis[4]. In no case has serum iron saturation been found. Further, among the Pondos and Bapedi examined, a few very low values for serum iron were obtained, which were, however, consistent with normal hæmoglobin levels.

Whether or not our groups with high serum iron and total iron-binding capacity values correspond with groups having high iron intakes, or displaying abnormal deposition of iron, is being investigated.

This communication is published by permission of the South African Council for Scientific and Industrial Research. For co-operation and help, we are grateful to Drs. R. C. Pearson and R. M. Yeo, and to Messrs. J. Lub and E. Rogers, of the Witwatersrand Native Labour Association Headquarters in Johannesburg; to Dr. F. Keen of the Johannesburg Non-European Hospital; and to Drs. I. Bersohn and M. L. Neser of this Institute.

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Sept. 12.

[1] Strachan, A. S., "Haemosiderosis and Haemochromatosis in South African Natives, with a comment on the Aetiology of Haemochromatosis", M.D. thesis, Glasgow (1929). Gillman, J., and Gillman, T., *Arch. Path.*, **40**, 239 (1945).
[2] Walker, A. R. P., and Arvidsson, U. B., *Nature*, **166**, 438 (1950). Walker, A. R. P., *Brit. Med. J.*, **14**, 819 (1951).
[3] Squires, B. T., *S. Afr. J. Med. Sci.*, **17**, 1 (1952).
[4] Rath, C. E., and Finch, C. A., *J. Clin. Invest.*, **28**, 79 (1949).
[5] Cartwright, G. E., and Wintrobe, M. M., *J. Clin. Invest.*, **28**, 86 (1949). Ventura, S., and Klopper, A., *J. Obstet. Gynaec. Brit. Emp.*, **58**, 173 (1951).

'Private' Blood Factors, Homozygosis, and the Search for New Blood Groups

Levine[1], in a review of the newer blood factors, classed several of them as 'private'. These, he said, "are characterized by the positive or negative reactions being limited to members of a particular family". He cited as 'private' five antibodies reported by various investigators. J. J. van Loghem and van der Hart[2] have since reported a sixth.

How 'private' a blood factor appears to be may depend upon the population studied with the antibody defining the factor. For example, a year or so ago, we received blood from an American Indian woman who, in her ninth pregnancy, gave birth to a baby who died of erythroblastosis. Her blood contained an antibody which agglutinated the blood of her husband and of some, though not all, of her seven living children, but did not agglutinate the blood of 794 other American Indians. Using the antibody on this population only, the factor it defined fell into the class of a 'private' blood factor; but when the antibody was tested with the blood of whites it was readily shown to be anti-*Kell*. The husband was found to be heterozygous *Kk*. On inquiry it was found that his mother was white. From this observation, we suggest that one should inquire into the racial origin of the stimulator of an antibody defining a 'private' blood factor, and if he be found to be of different race from the person who has developed the antibody, members of his race should be tested.

Sometimes, when questioning does not suggest that a person carrying a particular blood group antigen has a foreign ancestor, a hint may be obtained by detailed blood grouping. When we found anti-*D* in the blood of an *Rh*-negative woman, we genotyped the family. The husband was R_1R_z and the three children R_2r. R_z is rare in whites but common in American Indians. When we questioned the woman, she said that her husband's mother was born in Scotland, his father in Canada in a district where many Scots settled 140 years ago. She thought of him as a Scottish Canadian, or, as we would say, Caucasoid. But we know that originally the marriage of a white man to an Indian woman was the rule rather than the exception in the area where the husband's father was born. We have little doubt that his R_z came from an Indian ancestor. The finding of R_0 suggests the possibility of a negro ancestor, perhaps via a Mediterranean ancestor[3]. When no racial difference between stimulator and producer of an antibody is proved or suggested, members of as many racial groups as possible should be tested with the antibody, before the factor it defines is set down as 'private'. These 'private' antibodies may be of great ethnological value.

Other observations on American Indians led us to give some thought to homozygosis. In a study of the blood groups of the Blood and Blackfoot tribes of southern Alberta in the summer of 1952, we concluded that pure-bred Indians of these tribes were probably homozygous for the following blood antigens: *k*, *Lu*^{b}, 'not *Le*^{a}', *P* and possibly *D*. In such a population, so long as it remains pure-bred, and so long as any member, when transfused, receives blood from his own people only, an immune antibody against a factor for which the population is homozygous cannot be produced. So, for example, the pure-bred Indian cannot produce anti-*k*. On the other hand, the introduction of foreign blood antigens, whether through pregnancy or through transfusion, makes the probability of production of an antibody against one of these antigens greater than in the foreign population. In a random sample of 83 sera of Indian men, women and children, we found a second example of anti-*Kell*, whereas we have identified this antibody only half a dozen times in the examination of sera of some thousands of whites. Further, in such a population, naturally occurring antibodies against a blood factor having a frequency of zero may be present, but cannot be recognized by tests of the population. We have found several examples of anti-*Le*^{a} in the sera of Indians, while no Indian blood we have tested has reacted with this antibody. Indian blood, of itself, can give no hint of the *Lewis* system. Many Indian tribes are homozygous for *O*, or, to put it the other way about, have a frequency of zero for *A* and *B*. Their sera, of course, contains anti-*A* and anti-*B*. It comes as something of a shock to think what the history of the *ABO* system would have been had the American Indians been the population of primary investigation: for many tribes there would have been no evidence of its existence; for others the classification could only have been *A*+ and *A*−, for perhaps one tribe in South America *B*+ and *B*−.

Since some Indian populations are homozygous for some blood groups, it seems reasonable to believe that Caucasoid, Negroid, Mongoloid and Australoid populations may be homozygous for other blood groups. This is more likely to be true for populations which have resisted interbreeding or have had, until recently, relatively little opportunity for interbreeding, than it is for those which are highly interbred. In a population exhibiting homozygosis for any blood group, that group must remain unknown so long as tests are carried out only with sera of that population. It is our suggestion that a systematic examination of the sera of persons who have been transfused with the blood of donors of a different race or sub-race, and of the sera of women married to men of a different race or of a mixed race, may bring to light several unrecognized blood-group systems. An experimental programme of inter-racial immunization of volunteers would also be worth while. It need scarcely be said that it will be necessary to test the sera against the blood of persons of the race of the donor, or of the husband. It would be desirable, through exchange of sera between laboratories having access to other racial populations, to test the sera against the blood of several races.

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[1] Levine, P., *Trans. N.Y. Acad. Sci.*, **13**, 205 (1951).
[2] van Loghem, J. J., and van der Hart, M., Bull. Cent. Lab. Bloedtrans. Nederl. Rode. Kr., **2**, 225 (1952).
[3] Mourant, A. E., Cold Spring Harbor Symp. Quant. Biol., **15**, 221 (1950).

Adsorption of DDT on Suspended Solids in River Water and its Role in Black-fly Control

Recent investigations on the Saskatchewan River[1] indicate that DDT associated with suspended solids gave outstanding results in the control of black flies. Black-fly larvæ have been practically eliminated from other streams and rivers by the application of DDT at rates as low as 0·1 p.p.m.[2]; but the maximum distance of effectiveness was approximately nine

miles and some of the treatments were destructive to other aquatic life as well as black-fly larvæ. In contrast with these results, during 1948–51 larvæ of *Simulium arcticum* Mall. were largely eradicated from sections of the Saskatchewan River for as long as 98 miles by single applications of DDT. The DDT was applied at rates as low as 0·09 p.p.m. for 16 min. as a 10 per cent solution in methylated naphthalene and kerosene.

Outstanding characteristics of the Saskatchewan River include its large rate of discharge (up to 120,000 cusec.), its freedom from aquatic vegetation, and the turbidity of the water during certain seasons of the year. During the tests, the suspended solids content of the water ranged as high as 551 p.p.m., and samples obtained by sedimentation from river water collected so far as 68 miles downstream from the point of application contained 0·24–2·26 μgm. of DDT per gram of solids. This material consisted mainly of clay and fine silt, and laboratory experiments showed that it would adsorb DDT from suspensions of 0·1 p.p.m. of DDT in distilled water.

A study of the feeding habits of the larvæ of *S. arcticum* showed that suspended particles in the river water, including much inorganic material, were consumed. It was also noted during the larvicide tests that the treatments produced much greater mortality of black-fly larvæ than of other aquatic insects, which normally do not feed on small particles suspended in the water. Quantitative samples of aquatic organisms collected before and after single applications of DDT indicated that, whereas black-fly larvæ were almost eliminated for distances ranging from 40 to 98 miles, populations of other aquatic insects were reduced by an average of 50 per cent in two tests and were unchanged in two others.

The results suggest that other fast-flowing rivers in which the water is turbid at the time of treatment might be treated similarly, and perhaps in certain clear-water streams and rivers, finely divided inorganic material with marked DDT adsorptive properties could be added along with the larvicide and kept in suspension.

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[1] Fredeen, F. J. H., Arnason, A. P., Berck, B., and Rempel, J. G. (in preparation).

[2] Garnham, P. C. C., and McMahon, J. P., *Bull. Ent. Res.*, **37**, 619 (1947). Gjullin, C. M., Cope, A. B., Quisenberry, B. C., and DuChanois, F. R., *J. Econ. Ent.*, **42**, 1 (1949). Hocking, B., Twinn, C. R., and McDuffie, W. C., *Sci. Agric.*, **29**, 2 (1949). Hocking, B., *Sci. Agric.*, **30**, 12 (1950).

Terminology in Bacterial Genetics

The increasing complexity of bacterial genetics is illustrated by several recent letters in *Nature*[1]. What seems to us a rather chaotic growth in technical vocabulary has followed these experimental developments. This may result not infrequently in prolix and cavil publications, and important investigations may thus become unintelligible to the non-specialist. For example, the terms bacterial 'transformation', 'induction' and 'transduction' have all been used for describing aspects of a single phenomenon, namely, 'sexual recombination' in bacteria[2]. (Even the word 'infection' has found its way into reviews on this subject.) As a solution to this confusing situation, we would like to suggest the use of the term 'interbacterial information' to replace those above. It does not imply necessarily the transfer of material substances, and recognizes the possible future importance of cybernetics at the bacterial level.

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[1] Lederberg, J., and Tatum, E. L., *Nature*, **158**, 558 (1946). Cavalli, L. L., and Heslot, H., *Nature*, **164**, 1058 (1949). Hayes, W., *Nature*, **169**, 118 (1952).

[2] Lindegren, C. C., *Zbl. Bakt.*, Abt. II, **92**, 40 (1935).

Histochemical Demonstration of Amine Oxidase in Liver

Dianzani[1] has shown that ditetrazolium can be used for demonstrating the activity of, among other enzymes, tyramine (amine) oxidase in mitochondria isolated from liver and kidney. The essential reaction here is a dehydrogenation[2], and hydrogen acceptors other than oxygen may be used in the oxidation of tyramine by amine oxidase[3]. It is therefore of interest that amine oxidase activity can be demonstrated in frozen sections of the tissue, using a tetrazolium compound as the hydrogen acceptor; even though the method is not entirely satisfactory, it shows the general distribution of the enzyme. Neotetrazolium[4] was found to be much more satisfactory than blue (di-)tetrazolium.

Frozen sections (15–20 μ thick) of guinea pig and rabbit liver were well washed in phosphate buffer for about thirty minutes to remove all endogenous substrates and then incubated with equal parts of 0·1 per cent neo-tetrazolium, 0·1 *M* phosphate buffer of *p*H 7·4 and 0·5 per cent tyramine solution, for 2–4 hr. At the end of the incubation period, the sections were washed in distilled water, fixed in 10 per cent neutral formalin and mounted in dilute glycerol. The use of very thin slices of liver instead of frozen sections for the incubation was found to be advantageous; they can then be fixed in formalin and sectioned on the freezing microtome. Control sections were incubated with (1) octyl alcohol[5] for three hours before incubation with tyramine and (2) potassium cyanide in a final concentration of 3×10^{-3} *M*, which inhibits other oxidases but has no inhibitory effect on amine oxidase.

Fat stains red with neo-tetrazolium and, together with the precipitated blue formazan, gives a general purple colour. Large fat globules can be seen in the liver, staining a bright red. This red colour can be eliminated by treating the sections with acetone, which dissolves away the fat, leaving the true (blue) colour of the precipitate. The acetone is removed by washing with water. In many cases the red colour is of advantage as it serves as a counter stain.

For the same period of incubation guinea pig liver showed a more dense precipitate than rabbit liver.

The reaction was not uniform throughout the liver, being more marked in the periphery of the lobule, the centre being comparatively free. The precipitate was always in the cytoplasm of the cell; the nucleus did not show any reaction and was unstained. Octyl alcohol completely inhibited the reaction, no blue colour being visible anywhere in the tissue. Potassium cyanide had no effect on the reaction.

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[1] Dianzani, M. U., *Nature*, **171**, 125 (1953).
[2] Richter, D., *Biochem. J.*, **31**, 2022 (1937).
[3] Philpot, F. J., *Biochem. J.*, **31**, 856 (1937).
[4] Shelton, E., and Schneider, W. C., *Anat. Rec.*, **112**, 61 (1952).
[5] Blaschko, H., Richter, D., and Schlossmann, H., *Biochem. J.*, **31**, 2187 (1937).

Lactate-oxidizing Systems in the Mycobacteria

In a recent communication, Y. Yamamura, M. Kusunose and E. Kusunose[1] described two "lactic oxidases" prepared from *Mycobacterium avium*. "Lactic oxidase I" is said to be a new type of lactate-oxidizing system which catalyses the reaction:

$$CH_3.CHOH.COOH + O_2 \rightarrow CH_3.COOH + CO_2 + H_2O. \quad (1)$$

The authors are apparently unaware that a soluble aerobic dehydrogenase catalysing the same oxidation of L-lactate was extracted from *Mycobacterium phlei* several years ago[2]. Preparations of a similar, if not identical, enzyme have been obtained from *Mycobacterium smegmatis* and *Mycobacterium tuberculosis* var. *hominis* (*H*37 strain)[3]. For these and other reasons, it was suggested that L-lactic acid oxidase is an enzyme common to all species of acid-fast bacteria[4].

One of the hypotheses originally put forward to explain reaction (1) postulated three consecutive steps[2]:

$$CH_3.CHOH.COOH + F = FH_2 + CH_3.CO.COOH \quad (2)$$

$$FH_2 + O_2 = F + H_2O_2 \quad (3)$$

$$CH_3.CO.COOH + H_2O_2 = CH_3.COOH + CO_2 + H_2O \text{ (non-enzymic)} \quad (4)$$

Sum of reactions (2) to (4) = reaction (1).

In this scheme, *F* was assumed to be an autoxidizable flavoprotein containing flavin-adenine-dinucleotide because this class of protein was found in the enzyme preparations; but it was pointed out that the hypothesis could not be tested satisfactorily until purer preparations became available[2,4]. Yamamura *et al.* have likewise assumed that "lactic oxidase I" is a flavoprotein with flavin-adenine-dinucleotide as its prosthetic group.

Our assumption identifying the lactic enzyme with a flavoprotein has proved to be false. Using large quantities of bacteria, one of us (F. B. C.) has achieved a considerable purification of the L-lactate-oxidizing enzymes extractable from *Mycobact. phlei*, *Mycobact. smegmatis* and *Mycobact. stercoris*. These preparations exhibit identical enzymic behaviour. Flavins (free and combined) are removed during the purification, details of which will be published elsewhere. The most active preparation from *Mycobact. smegmatis* has Q_{O_2} (per mgm. nitrogen) = 166,000 at the optimum *p*H (5·2) and at 38°. This is sixty times as active as the best preparation of Yamamura *et al.*

Concentrated solutions of partially purified enzyme are orange-yellow in colour and exhibit three electrophoretic components, one of which contains the enzyme. The pigment migrates with the enzyme. The absorption spectrum shows typical protein bands in the ultra-violet region with additional absorption at 380–403 mμ due to the pigment. It is possible that the pigment is a prosthetic group of the enzyme, but this is unlikely since the pigment is removed progressively as the enzyme is purified.

Mechanism of reaction. Yamamura *et al.* consider that their experiments exclude the possibility of formation of hydrogen peroxide. The evidence seems to be that oxygen consumption and carbon dioxide production in reaction (1) are unaffected by addition of catalase or catalase plus ethanol. This evidence shows (*a*) that catalase does not inhibit the oxidation of lactate, and (*b*) that coupled oxidation does not occur in the presence of ethanol and catalase (carbon dioxide production unaltered). Though significant, this evidence is not conclusive. If pyruvate and hydrogen peroxide react spontaneously on the enzyme surface where they originate, there may be limited diffusion of hydrogen peroxide to an indicator system.

Our purified enzyme preparations behave in a similar way with catalase. Nevertheless, the experiment illustrated in the accompanying table supports the view that hydrogen peroxide is formed in accordance with reactions (2) and (3). The experiment employs horseradish peroxidase and *p*-aminobenzoic acid as a means of detecting hydrogen peroxide[5]. In the presence of peroxidase, *p*-aminobenzoic acid is oxidized only when lactate is oxidized simultaneously; in the absence of peroxidase there is no coupling.

Detection of Hydrogen Peroxide during the Oxidation of Lactate

Additions	Oxygen uptake (μl./60 min.)	Dye formation
Nil	0	Nil
p-Aminobenzoic acid + peroxidase	0	Nil
Lactate	381	Nil
Lactate + *p*-aminobenzoic acid	394	Nil
Lactate + peroxidase	345	Nil
Lactate + *p*-aminobenzoic acid + peroxidase	384	Red
Pyruvate + *p*-aminobenzoic acid + peroxidase	0	Nil

Warburg manometric cups contained: 0·2 ml. enzyme solution (L-lactic acid oxidase from *Mycobact. smegmatis*) and 0·9 ml. 0·2 *M* acetate buffer, *p*H 5·2. Gas, air. Temp., 38. Inseal, 0·2 ml. 2 *N* sodium hydroxide. Additions: 1·0 *M* DL-lactate (0·5 ml.); 0·2 *M* pyruvate (0·5 ml.); peroxidase solution (0·2 ml.); 0·025 *M* *p*-aminobenzoic acid (0·2 ml.); water to make total volume, 2 ml. in each case.

We have not encountered a DPN-linked anaerobic dehydrogenase like "lactic oxidase II" in the organisms we have studied.

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[1] Yamamura, Y., Kusunose, M., and Kusunose, E., *Nature*, **170**, 207 (1952).
[2] Edson, N. L., *Biochem. J.*, **41**, 145 (1947).
[3] Geronimus, L. H., Gray, C. T., and Birkeland, J. M., Abstracts of Papers, Soc. Amer. Bacteriologists, 49th General Meeting, 42 (1949).
[4] Edson, N. L., *Bact. Rev.*, **15**, 165 (1951).
[5] Lipmann, F., *J. Biol. Chem.*, **139**, 977 (1941).

A Sphincter in the Umbilical Ring of the Rabbit

DURING the course of some experiments on fœtal rabbits, a very marked constriction was observed in the umbilical cord at the umbilical ring; the abrupt narrowing in this region accompanied the closure of the length of the umbilical vessels in response to traction or to cooling of the cord. A circular band of smooth muscle in the umbilical ring region has been described for the horse[1] but for no other animal, and Sir Joseph Barcroft suggested that the structure of the rabbit's umbilical cord should be studied in more detail.

Serial sections of the umbilical vessels, in the full-term fœtal rabbit, showed that there is a thin layer of unstriped muscle fibres surrounding their adventitia; this was recognizable around the branches of both the arteries and the vein a few millimetres from where they emerge from the placenta. When the three large umbilical vessels lie side by side in the umbilical cord proper, the outer portions of this muscle layer fuse and the muscle fibres can be seen circularly arranged under the amniotic sheath; the inner portions of the muscle layer between the three umbilical vessels gradually disappear. The circular fibres increase in number and the sphincter attains its maximal thickness 2–3 mm. in front of the abdominal wall; it continues thus for 2–3 mm. inside the abdomen, and gradually tapers to its connexion with the abdominal muscle. Ranson impregnation, together with control positive material, revealed no nervous supply to the sphincter. It was already present in the cord of 20-day rabbit fœtuses. No similar structure was found in the rat, in the human or in the guinea pig umbilical ring.

It is doubtful whether this sphincter has any physiological function *in utero*, since it is not innervated and responds most readily to local stimulation. At birth it is obviously an efficient mechanism for ensuring closure of the three umbilical vessels, for in the region of the sphincter there is more complete reduction in the size of the lumen of the three vessels than is found on either the fœtal or placental side of the umbilical ring. It is difficult to understand its special relationship to the mechanism of birth in the rabbit. However, effective closure of umbilical vessels may be a function of their length as well as the relative contractile properties of the vessel walls. The latter is impossible to assess from histological specimens; but it is noteworthy that the umbilical cord proper in the rabbit is comparatively short, and the sphincter may have been developed as an extra safeguard.

Transverse section of umbilical ring of the rabbit showing unstriped muscle sphincter surrounding umbilical vessels

This work was begun in the Department of Physiology, Bedford College for Women, London. My thanks are due to Miss Beryl Shilton, who prepared many of the slides. Miss Helen Perry, of the Department of Zoology, Birkbeck College, London, is carrying out an exhaustive study of the umbilical rings in other animals.

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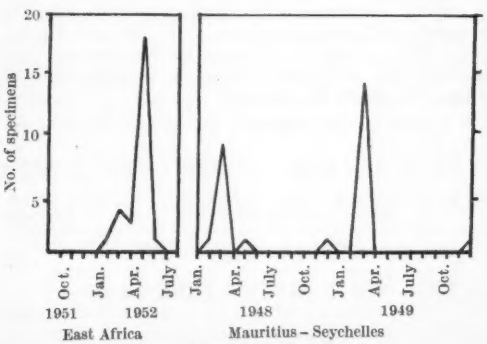
[1] Hauptmann, E., *Arch. Anat. Physiol. Lpz.*, Anat. Abt., 103 (1911).

Catches of *Coryphæna hippurus* (L.) in the Western Indian Ocean

WHILE carrying out a survey of the pelagic fishes of East African waters, twenty-seven specimens (twenty-four female, three male) of the dorade or dolphin fish were caught during multiple trolling operations during September 1951–August 1952. All the dorade were taken close inshore, and from the graph it can be seen that the catches were limited to the months February–June. Although the total catch is not large, it must be remembered that the dorade is of widespread distribution in tropical seas and is nowhere abundant. In all specimens the state of maturity of the gonads was determined.

Reference to unpublished data of the Mauritius–Seychelles Fisheries Survey, 1948–49 (Wheeler and Ommanney), provides evidence of the capture of twenty-seven dorades (seventeen female, ten male). With one exception, they were taken on or near the many shallow-water banks of this area. No ripe females were noted; but ripening females occurred in March in both years. In East African waters ripening females occurred from March to May, and ripe females in May.

These observations suggest that *Coryphæna* makes an inshore spawning migration between February and June in the western Indian Ocean. Confirmation



Catches of *Coryphæna hippurus* (L.)

or otherwise of the movement indicated should be obtained during the future work of the survey.

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A Biological Agent for securing Large Numbers of *Amœba proteus*

The role of *Oscillatoria* for purifying freshwater reservoirs is well known. For some years now, I have been applying successfully this biological agent to 'cleaning up' amœba cultures. Ordinary laboratory cultures, unless rigidly controlled, tend to become choked with algæ in the course of time. It is a tiresome manipulation to separate out the amœbæ in sufficient numbers when it is desirable to make a quantity of stained preparations, or to secure the large numbers of young amœbæ which are required when a study of mitosis is being made. If, however, among the algal contents one introduces *Oscillatoria*, the filaments of this grow over and bind together the wheat grains and the algal contents into a cylindrical mass. The rest of the vesicle is quite free from weed; but young amœbæ, some rotifers and small flagellates creep out on to it and multiply, and so a white carpet is formed consisting mainly of amœbæ quite free from debris. These can then be pipetted off into the fixative, or used for a study of mitosis.

If now a new receptacle with water and wheat be prepared, the cylindrical mass can be removed bodily, placed into the prepared receptacle and squeezed, when a new culture results, which will be ready for use in about three months.

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Laws of Addition and Substitution in Atomic Reactions of Halogens

Quantitative developments of the observations communicated some time ago[1] on the reaction of N-chlorosuccinimide with toluene has led to a clarification of the reaction mechanism.

Let us, however, consider first the reactions between an organic substance (RH) and a halogen (X_2) in homogeneous gaseous systems or in non-polar solutions. If the reaction proceeds by atoms and free radicals, the following reactions (substitution s, addition a) must be expected:

$$X_2+M \rightarrow 2X+M \qquad (1)$$

$$X+HR \rightarrow HX+R \ (2s) \qquad X+RH \rightarrow XRH \qquad (2a)$$

$$R+X_2 \rightarrow RX+X \ (3s) \qquad XRH+X_2 \rightarrow XRHX+X \qquad (3a)$$

$$R+HX \rightarrow RH+X \ (4s) \qquad XRH \rightarrow RH+X \qquad (4a)$$

$$X+XR \rightarrow X_2+R \ (5s) \qquad X+XRHX \rightarrow X_2+XRH \qquad (5a)$$

$$2X+M \rightarrow X_2+M \qquad (6)$$

$$X+R \rightarrow XR \qquad (7s) \qquad X+XRH \rightarrow XRHX \ (\text{or } X_2+RH) \qquad (7a)$$

$$R+R \rightarrow R_2 \qquad (8s) \qquad XRH+XRH \rightarrow XRH/HX \ (\text{or } XRHX+RH) \qquad (8a)$$

By applying the usual stationary state method, the rate laws in $(X_2)^{1/2}$, (X_2) or $(X_2)^{3/2}$, which were found empirically by Bodenstein, Kistiakowsky, Schumacher, Van Artsdalen and others[2], are obtained. But it can be shown, in agreement with all previous observations, which of these rate laws must be expected in any specific case, by estimating the rate constants, that is, activation energies and partition functions for the eight different elementary steps. A quite satisfactory 'first approximation' is obtained in the following way: it is assumed that activation energies exceed endothermicities by 2 to 5 k.cal.; electronic and vibrational partition functions are assumed to be equal for all particles, and rotational partition functions are calculated neglecting structural particularities.

Further, the rules governing the competition of addition and substitution may be calculated; the ratio of addition to substitution being:

$$r(a/s) = k_{2a}/k_{2s}(1 + k_{4a}/k_{3a}(X_2)),$$

or for low concentrations of (X_2)—the order of magnitude of which can be estimated satisfactorily:

$$r(a/s) = k_{2a}k_{3a}(X_2)/k_{2s}k_{4a}.$$

Thus addition is favoured by high, substitution by low, values of (X_2); this explains the 'perturbations' of addition reactions observed, for example, by Schumacher[3].

It has been shown that in the reaction of N-chlorosuccinimide with toluene, traces of impurities (for example, 10^{-5} water) lead, in the course of an induction period[4], to formation of HX, which yields with N-chlorosuccinimide halogen molecules (X_2); the latter give by thermal dissociation the primary halogen atoms. These could now react according to $(2s)$ or $(2a)$. In the first case, the following reaction chain would be started:

$$X + HR \rightarrow XH + R \qquad (a)$$

$$SNX + XH \rightarrow SNH + X_2 \qquad (b)$$

$$R + X_2 \rightarrow RX + X \qquad (c)$$

It can easily be understood that $(2a)$ cannot be followed by a rapid reaction: (i) actually the above substitution–addition rule means that $(3a)$ is slow as compared to $(4a)$ so long as (X_2) is low; (ii) the alternative reaction, $SNX+XRH \rightarrow SN+XRHX$, is only possible if the dissociation energy of the $SN—X$ bond is smaller than or equal to an $X—X$ bond; we have several indirect arguments for the contrary. (This reaction is certainly negligible compared with $3a$ because of its high (negative) entropy of activation.)

Thus the reactions (a), (b) and (c) are the only alternative. They explain all the observed facts[4], and we believe that they can be applied also in the case of other reagents giving atomic halogenations. It is not necessary to admit *ad hoc* a 'specificity' of the SN radical, as has been done previously[5].

Actually it appears, for the first time quantitatively, that the high specificity of reagents is due to the concentration at which reagents are maintained in a system, much more than to the inherent specificity of these reagents. We believe that this may have general importance in biological reactions. In fact,

more than twenty years ago, one of us (P. G.) was able to discuss this possibility many times with the late Profs. F. Haber and R. Willstätter, when they first suggested the role of atomic and free radical reactions in enzymatic processes[6]; we did not succeed then, however, in putting forward an adequate quantitative model[7].

Two of us (J. A. and P. A. G.) wish to express our thanks to the Institute of Applied Scientific Research (I.R.S.I.A.), Brussels, for fellowships, which have enabled us to carry out this investigation.

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[1] Goldfinger, P., Gosselain, P. A., and Martin, R. H., *Nature*, **168**, 30 (1951).
[2] For example, Noyes, jun., W. A., and Leighton, P. A., "The Photochemistry of Gases" (Amer. Chem. Soc. Monograph 86, N.Y., 1941).
[3] Schumacher, H. J., and Müller, K. L., *Z. phys. Chem.*, **35** B, 285 (1937).
[4] Cf. ref. 1 and further details in a forthcoming publication in *Bull. Soc. Chim. Belg.*
[5] Dewar, M. J. S., "The Electronic Theory of Organic Chemistry" (Oxford, 1949).
[6] Haber, F., and Willstätter, R., *Ber. d. deut. chem. Ges.*, **64**, 2844 (1931).
[7] Goldfinger, P., and Graf, v. Schweinitz, H. D., *Z. phys. Chem.*, B **22**, 241 (1933).

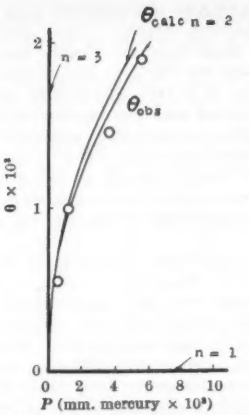
Dissociative Chemisorption of Carbon Dioxide on Solid Catalysts

THE chemisorbed state or the degree of dissociation of a polyatomic molecule on the surface of a solid catalyst may be important for understanding the catalysed reaction. We know little, however, for example, of the state of carbon dioxide, ethylene and other molecules, or even of such a simple diatomic molecule as carbon monoxide; in the latter case, contradictory views as to whether its chemisorbed state on a metallic surface is molecular or atomic have been put forward.

Kwan and Fujita[1] have recently investigated the chemisorption of carbon dioxide on reduced nickel at 200° C. with particular reference to its chemisorbed state, using statistical mechanical consideration, and we conclude that it is completely dissociated into three statistically independent atoms. This statement was borne out by the following fact. Using the heat of chemisorption of carbon dioxide derived from the isotherm for a sparsely covered surface, the fraction of surface covered, θ, was calculated from the expression:

$$\theta^n = \frac{P}{P_0} \exp \Delta\varepsilon/RT, \qquad (1)$$

where n is 1 when the substrate molecule is undissociated at the surface and 2 or 3 respectively for the



Chemisorption isotherm of carbon dioxide on copper ferrite at 300° C.

case when dissociated into two or three parts, $\Delta\varepsilon$ is the heat of chemisorption, P the equilibrium pressure and P_0 a constant, being expressed for the present case as:

$$P_0 = kT \frac{(2\pi mkT)^{3/2}}{h^3} \frac{4\pi^2 IkT}{h^2} \prod_i \{1 - (\exp -h\nu_i/kT)\}^{-1} \exp 7/2.$$

The fraction covered was also derived from the amount of carbon dioxide chemisorbed and the Brunauer–Emmett–Teller surface area[2] of the adsorbent, assuming that each metal atom at the surface is equally capable of chemisorbing a dissociated particle. This was compared with the coverage given by equation (1) for three different chemisorbed states respectively. It was found that much better agreement between them can be attained when completely dissociative chemisorption, that is, $n = 3$, is assumed.

The method of investigation has now been applied to chemisorption on oxide catalysts of spinel type. Copper ferrite, copper chromite and zinc chromite, respectively, were prepared by the usual precipitation from the stoichiometric mixture of the corresponding salt, and dried and ignited in vacuum at 500° C. The 1 : 1 stoichiometric proportion of $MeO—Me_2O_3$ was confirmed in each case by chemical analysis and also the spinel structure by X-ray analysis.

The chemisorption isotherm of carbon dioxide was determined at temperatures ranging from 100° to 300° C. and at pressures from 10^{-3} to 1 mm. mercury by the same method as that described in a previous paper[3]. The isothermal heat was found to be 31, 21 and 16 ± 0·5 k.cal./mole, respectively, for copper ferrite, copper chromite and zinc chromite. The plot of the coverage against equilibrium pressure, for example, in the case of copper ferrite when $n = 1$,

$\theta_{obs.}$ AND $\theta_{calc.}$ FOR CHEMISORPTION OF CARBON DIOXIDE

Oxide	Wt. (gm.)	Surface area (M^2)	T (° C.)	P* (mm. mercury	$\Delta\varepsilon$ (k.cal./mole^{-1})	No. of chemisorbed CO_2 molecules per cm.$^{-2}$	Fraction of surface covered			
							$\theta_{obs.}$	$\theta_{calc.}$ $n = 2$	$\theta_{calc.}$ $n = 1$	$\theta_{calc.}$ $n = 3$
$CuFe_2O_4$	4·2	210	300	0·01	31	$1·3 \times 10^{12}$	$2·6 \times 10^{-3}$	$2·8 \times 10^{-3}$	$7·6 \times 10^{-6}$	$1·9 \times 10^{-3}$
$CuCr_2O_4$	1·0	43	200	0·01	21	$2·3 \times 10^{11}$	$4·6 \times 10^{-4}$	$4·9 \times 10^{-4}$	$2·4 \times 10^{-7}$	$6·2 \times 10^{-3}$
$ZnCr_2O_4$	3·5	103	100	0·01	16	$4·5 \times 10^{11}$	$4·0 \times 10^{-4}$	$4·1 \times 10^{-4}$	$1·7 \times 10^{-7}$	$5·5 \times 10^{-3}$

* P was taken arbitrarily within the range of the observed chemisorption isotherm.

2 and 3, respectively (denoted by '$\theta_{calc.}$'), is shown in the accompanying graph. This shows that only when $n = 2$ does $\theta_{calc.}$ fit closely the experimental value (denoted by '$\theta_{obs.}$'), which was obtained by assuming that 5×10^{14} metal ions or the average numbers of metal ions per square centimetre of the adsorbent surface are equally capable of chemisorbing each dissociated particle. The result is obviously in contrast to that for nickel quoted above. A similar result was also obtained in the case of copper chromite and zinc chromite, as shown in the accompanying table.

As can be seen from the table, if we assume that $n = 1$ or 3, the fraction covered, or $\theta_{calc.}$, fails to account entirely for the experimental value ($\theta_{obs.}$) for any of the oxide catalysts, whereas $\theta_{calc.}$ corresponding to $n = 2$ gives a good fit. Quite apart from the numerical agreement between $\theta_{calc.}$ and $\theta_{obs.}$ in the latter case, it seems very likely that the carbon dioxide molecule is chemisorbed with partial dissociation into two particles, that is, presumably into chemisorbed carbon monoxide and oxygen atoms.

Detailed accounts of this work will be published in *J. Res. Inst. Catalysis, Hokk. Univ.* Our thanks are due to Prof. J. Horiuti for his advice.

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Sept. 29.

[1] Kwan, T., *J. Chem. Phys.*, **18**, 1309 (1950). Kwan, T., and Fujita, Y., *Bull. Chem. Soc. Japan*, **24**, 46 (1951).
[2] Brunauer, S., Emmett, P. H., and Teller, E., *J. Amer. Chem. Soc.*, **60**, 309 (1938).
[3] Kwan, T., *J. Res. Inst. Catalysis, Hokk. Univ.*, **1**, No. 2, 81 (1949).

Preparation of Single Crystals of Titanium and their Mode of Deformation

Single crystals up to 20 mm. × 2·5 mm. × 1 mm. have been prepared in pure titanium by a modified strain anneal technique. Pure titanium of hardness of 90 V.P.N., indicating 0·01 wt. per cent of oxygen plus nitrogen[1], prepared in this laboratory by the van Arkel process, was first arc-melted[2] and then cold-rolled with intermediate annealing at 860° C. to strip in which there was very little preferred texture. By suitably gettering the purified argon used as a protective atmosphere throughout this preparation, the hardness of the titanium was not increased. The grain-size of this strip was fairly coarse and uneven (1–25 grains/mm.^{2}). Tensile strains from 0·05 to 5 per cent did not give large crystals on annealing for 90 hr. at 860° C.; but compressive strains between 0·1 and 1 per cent, followed by similar annealing, produced in one-third of the specimens a crystal occupying the whole cross-section and an appreciable part of the gauge length, as illustrated.

In a less pure titanium (V.P.N. 165, 0·1 wt. per cent oxygen plus nitrogen[1]) the strip had an even grain-size of 20–25 grains/mm.^{2}. Compressive strains produced no appreciable grain growth on the annealing; but a tensile strain of $1\frac{1}{2}$–$2\frac{1}{2}$ per cent resulted in single crystals.

It is suggested that the purity of the titanium influences the techniques required to produce single crystals because it affects the initial grain size of the strip. It is known that initial grain size is a critical factor in the technique of strain anneal growth[3].

Single crystal of titanium, etched in 8 per cent nitric acid, 8 per cent hydrofluoric acid in water. × about 4

The size required in titanium (25 grains/mm.^{2}) is coarse in comparison with the size required in Armco iron (120 grains/mm.^{2}) and is thought to be necessary to reduce deformation twinning during the critical straining. In a specimen with an initial grain size of 100 grains/mm.^{2} the critical straining induced a considerable amount of deformation twinning, and subsequent annealing produced no enhanced grain growth, but the deformation twins did disappear.

During tensile tests in a rigid machine at room temperature it has been shown that, when suitably oriented, single crystals of pure titanium slip on (0001) [11$\bar{2}$0] as well as on (10$\bar{1}$0) [11$\bar{2}$0] and (10$\bar{1}$1) [11$\bar{2}$0]. Rosi, Dube and Alexander[4] only observed slip on (10$\bar{1}$0) [11$\bar{2}$0] and (10$\bar{1}$1) [11$\bar{2}$0] in work with coarse polycrystalline titanium made by the Kroll process. Slip on (0001) [11$\bar{2}$0] has been shown to be required if the rolling textures in titanium are to be completely accounted for[5]. The critical resolved shear stress for slip on the basal plane appears to be higher than that for slip on (10$\bar{1}$1), which is in turn higher than that for slip on (10$\bar{1}$0). Deformation twinning on (10$\bar{1}$2) and (11$\bar{2}$1) has been observed. Deformation or kink bands are formed both during basal and (10$\bar{1}$0) slip, and the bend plane has been identified as the (11$\bar{2}$0) plane at right angles to the operative slip direction. The bent region of the lattice at the boundary of the band exhibits asterism, while the slipped region outside and inside the band does not. On annealing, the bent region polyganizes as shown by the break up of the asterism into discrete spots and the appearance of boundaries at right angles to the slip lines on the micro structure.

The stress–strain curve at room temperature shows a drop in load required to maintain plastic flow reminiscent of the yield phenomena in iron, but which appears to coincide with the appearance of the deformation band.

A more complete survey of these results is in the course of preparation for publication.

I wish to thank Dr. G. A. Geach, leader of the Physical Metallurgy Section of this laboratory, for encouragement and helpful discussion; I also wish to express my thanks to Dr. T. E. Allibone for permission to publish this paper.

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April 9.

[1] Cross, H. C., O.N.R. Symposium on Titanium, Washington, 1949. Jenkins and Worner, *J. Inst. Met.*, **80**, 157 (1951).
[2] Geach, G. A., and Summers-Smith, J. D., *Metallurgia*, **42**, 153 (1950).
[3] Edwards, C. A., and Pfeil, L. B., *J. Iron and Steel Inst.* (II), 109, 129 (1924).
[4] Rosi, F. D., Dube, C. A., and Alexander, B. H., *J. Metals*, **5**, 257 (1953).
[5] Williams, D. N., and Eppelsheimer, D. S., *Nature*, **170**, 146 (1952).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, April 20

SOCIETY OF CHEMICAL INDUSTRY, CROP PROTECTION PANEL of the AGRICULTURE GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Annual General Meeting; Dr. J. R. Boer: "Organo-Mercurial Fungicides".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "Laboratory Experiments on Protective Gear" (to be opened by Mr. H. P. Young).

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. Sebastian Snow: "Amazon Adventure".

Tuesday, April 21

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Dr. Peter F. C. Castle: "The National Institute of Industrial Psychology Foremanship Research, 1948–1953".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S.W.7), at 2.30 p.m.—Dr. H. L. Penman: "Estimating the Water Requirements of Plants".

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 6 p.m.—Mr. H. S. Gibson: "Two Oilfields in Northern Iraq" (Presidential Address).

Wednesday, April 22

INSTITUTE OF PETROLEUM (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Symposium on "The Engine Testing of Lubricating Oils".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. H. M. Barlow and Mr. A. E. Karbowiak: "An Investigation of the Characteristics of Cylindrical Surface Waves"; Prof. H. M. Barlow and Dr. A. L. Cullen: "Surface Waves".

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL of the FOOD GROUP (in the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Dr. W. F. J. Cuthbertson: "Synthetic Food Possibilities"; Mr. P. N. Williams: "Synthetic Fats". Summary of Series by Dr. Norman Wright (Food and the Future, 4).

Wednesday, April 22—Saturday, April 25

INSTITUTE OF METAL FINISHING (at the Hotel Majestic, Harrogate).—Spring Conference.

Thursday, April 23

INSTITUTION OF CHEMICAL ENGINEERS (at the May Fair Hotel, Berkeley Street, London, W.1), at 11 a.m.—Thirty-first Annual Corporate Meeting; at 12 noon.—Mr. Stanley Robson: "Changes in Roasting Practice and Furnace Design" (Presidential Address).

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Geoffrey Taylor, F.R.S.: "Experimental Study of Standing Waves"; Mr. T. V. Davies: "Forced Flow of a Rotating Viscous Liquid which is Heated from Below".

LINNEAN SOCIETY (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. S. M. Manton, F.R.S.: "The Structures, Habits and Evolution of Millipedes".

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Sir Alexander Carr-Saunders: "Colonial Universities To-day" (Holland Memorial Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. P. I. Dee, F.R.S.: "The Dilemma of Lord Kelvin" (Forty-fourth Kelvin Lecture).

Friday, April 24

SOCIETY OF CHEMICAL INDUSTRY, OILS AND FATS GROUP (at the Low Temperature Research Station, Downing Street, Cambridge), at 10.30 a.m.—Symposium on "Oxidation" (Speakers: Prof. C. E. H. Bawn, F.R.S., Dr. C. H. Lea, Dr. A. Banks, Dr. L. A. O'Neill and Dr. J. H. Skellon).*

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. A. T. Bowden, Mr. P. Draper and Mr. H. Rowling: "The Problem of Fuel Oil Ash Deposition in Open-Cycle Gas Turbines".

TELEVISION SOCIETY (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Fleming Memorial Lecture.

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion Meeting on "Rockets" (Chairman: Prof. A. D. Baxter; Speakers: Dr. A. C. Merrington, Mr. I. Lubbock and Prof. A. D. Baxter).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. Archibald G. B. Russell: "Tradition and the Coronation".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT STATISTICIAN (with a university honours degree in science, mathematics or economics, and some experience of research involving the analysis and interpretation of mass data) in the Central Statistical Office of the Town Clerk's Department—The Town Clerk, Room 30B, Council House, Birmingham 1 (April 25).

ENTOMOLOGIST (male, interest in ecology and mechanical ability important) for work in Insecticides Department primarily in connexion with field experiments—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (April 25).

MECHANICAL ENGINEER or PHYSICIST (with first- or second-class honours degree or equivalent in mechanical engineering or physics) at the Royal Aircraft Establishment, Farnborough, to undertake experimental and theoretical work with light mechanisms—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.169/53A (April 25).

PHYSIOLOGIST (with good honours degree in physiology or equivalent qualification, and research experience preferably involving the perfusion of isolated organs) for research on the physiology of lactation—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 53/3 (April 25).

STATISTICIAN (part-time, graduate of a British university, with an honours degree, and statistical experience) in the Health and Welfare Department—The Town Clerk, Town House, Aberdeen (April 27).

READERSHIP IN MATHEMATICS at Westfield College—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 28).

UNIVERSITY DEMONSTRATOR IN ANIMAL NUTRITION—The Secretary, School of Agriculture, Downing Street, Cambridge (April 28).

UNIVERSITY LECTURER IN AGRICULTURAL BOTANY—The Secretary, School of Agriculture, Downing Street, Cambridge (April 28).

ASSISTANTS (2) IN MATHEMATICS, and an ASSISTANT IN STATISTICS—The Secretary, The University, Aberdeen (April 30).

READERSHIP IN CHEMICAL PATHOLOGY at the Royal Veterinary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

READERSHIP IN PUBLIC HEALTH at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 1).

TEMPORARY LECTURER (with special reference to horticulture) in THE DEPARTMENT OF BOTANY—The Registrar, The University, Manchester 13 (May 1).

CHAIR OF APPLIED MATHEMATICS—The Registrar, University College, Singleton Park, Swansea (May 2).

PHYSICIST or ENGINEER (with first- or second-class honours degree or equivalent in physics or engineering) in the Instrument and Photographic Department of Royal Aircraft Establishment, Farnborough, for research and development work in connexion with gyroscopic equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.88/53A (May 2).

READERSHIP IN GEOGRAPHY, and an ASSISTANT LECTURER IN ZOOLOGY—The Registrar, Trinity College, Dublin (May 10).

LECTURER IN CIVIL ENGINEERING—The Secretary, Queen's University, Belfast (May 15).

ASSISTANT (male, with a degree in horticulture, agriculture, or botany, together with a keen interest in the scientific aspects of practical fruit culture and ability to convey the results of research to scientists, advisory officers and growers) IN THE SCIENTIFIC LIAISON SECTION—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (May 16).

ORGANIC CHEMIST (Senior Research Officer grade)—The Director, Laboratory of Human Nutrition, Oxford (May 16).

SENIOR LECTURER or LECTURER IN COAL MINING ENGINEERING at the New South Wales University of Technology—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (May 25).

ASSISTANT LECTURER IN ARCHÆOLOGY—The Registrar, University College, Cathays Park, Cardiff (May 30).

SENIOR LECTURER IN PHYSIOLOGY—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (June 20).

ASSISTANT LECTURER (with honours degree in physics, preferably with a special interest in illumination or optics) IN THE DEPARTMENT OF APPLIED PHYSICS—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1.

ASSISTANT LECTURER and a DEMONSTRATOR IN ORGANIC CHEMISTRY—The Registrar, The University, Nottingham.

BIOCHEMIST (with a first- or second-class honours degree in chemistry, and research experience preferably in the field of protein chemistry) in the Endocrine Unit—The Secretary, London Hospital Medical College, Turner Street, London, E.1.

CHEMIST to assist in laboratory dealing with members' day-to-day production problems—The Printing, Packaging and Allied Trades Research Association, Randalls Road, Leatherhead, Surrey, quoting CE.

CHOWN RESEARCH PROFESSORSHIP IN CHEMISTRY—The Principal, Queen's University, Kingston, Ont., Canada.

ENGINEERS or PHYSICISTS for Royal Aircraft Establishment, Farnborough: SCIENTIFIC OFFICER-ENGINEER (preferably aeronautical) or PHYSICIST, for research on flutter and vibration problems in aircraft structures (Ref. A.81/53A), and a SENIOR S.O.-ELECTRICAL or ELECTRONIC ENGINEER, for development and application of electrical and electronic equipment in connexion with above research (Ref. D.121/53A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

PHYSICIST as HEAD OF THE PHYSICS DEPARTMENT—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

RESEARCH STUDENT IN THE CANCER RESEARCH DEPARTMENT, to work on problems concerning the mechanism of enzyme synthesis—The Secretary, London Hospital Medical College, Turner Street, London, E.1.

SCIENTIFIC OFFICERS (with first- or second-class honours degree, or equivalent, in physics or engineering) for operational research on a wide variety of problems, in London and provinces, under direction of Scientific Adviser to the Air Ministry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.285/52A.

SCIENTIFIC OFFICERS, Grade I and Grade II (with a good honours degree in engineering or mathematics; some research experience in either mechanical or civil engineering is essential for Grade I) IN THE RESEARCH DEPARTMENT (Engineering Division) at Derby—The Director of Research, Railway Executive, 222 Marylebone Road, London, N.W.1.

SENIOR RESEARCH WORKER, and a RESEARCH ASSISTANT, to undertake a fundamental study of the viscosity of liquid metals—The Registrar, The University, Edmund Street, Birmingham 3.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement

Great Britain and Ireland

Air Ministry: Meteorological Office. Geophysical Memoirs No. 89: Temperature and Humidity Gradients in the First 100 m. over South-East England. By A. C. Best, E. Knighting, R. H. Pedlow and K. Stormonth. (M.O.530d.) Pp. 60. (London: H.M. Stationery Office, 1952.) 7s. 6d. net. [92

Careers in the Royal Dutch/Shell Group. Second edition. Pp. 82. Careers for Chemical Engineers and Chemists. Pp. 22. Careers for Civil, Electrical and Mechanical Engineers and Surveyors. Pp. 29. Careers for Geologists and Geophysicists. Pp. 28. Careers in the Petroleum Chemical Industry. Pp. 22. (London: Shell Petroleum Co., Ltd., 1952.) [92

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences, No. 898, Vol. 245: On the Approximation of Logarithms of Algebraic Numbers. By K. Mahler. Pp. 371–398. (London: Cambridge University Press, 1953.) 6s. 6d. [92

Bulletin of the British Museum (Natural History). Zoology, Vol. 1, No. 11: Taxonomy of the Karroo and Red-back Larks of Western South Africa. By J. D. Macdonald. Pp. 319–350+plates 36–38. (London: British Museum (Natural History), 1953.) 10s. [92

London School of Hygiene and Tropical Medicine: Ross Institute Industrial Advisory Committee. Bulletin No. 7: Malaria and its Control for Planters and Miners. By Dr. G. Macdonald. Pp. 52. (London: London School of Hygiene and Tropical Medicine, 1952.) [102

Report on the Conference on Industry and the Universities, organized by the FBI North Midland Regional Council and the University of Nottingham and held at the University, 24 September 1952. Pp. vii+39. (London: Federation of British Industries, 1953.) 4s. 6d. [102

Ministry of Fuel and Power. 30th Annual Report on Safety in Mines Research, 1951. Pp. 56+4 plates. (London: H.M. Stationery Office, 1952.) 2s. 6d. net. [102

Forty-fifth Annual Report of the Governing Body of the Imperial College of Science and Technology. Pp. 60. (London: Imperial College of Science and Technology, 1953.) [102

Aluminium Development Association. Information Bulletin No. 20: Painting Practice for Aluminium. Pp. 20. (London: Aluminium Development Association, 1952.) 2s. [102

Forestry Commission. Census Report No. 1: Census of Woodlands, 1947–1949; Woodlands of Five Acres and Over. Pp. 264+11 plates. (London: H.M. Stationery Office, 1952.) 12s. 6d. net. [102

Agricultural Research Council. Report Series No. 12: The Technique of Complement-Fixation in Foot-and-Mouth Disease Research. By Dr. J. B. Brooksby. Pp. vi+40. (London: H.M. Stationery Office, 1952.) 6s. 6d. net. [102

Plant Environment and the Grower. By Sidney A. Searle. Pp. v+50. (London: C. F. Casella and Co., Ltd., in collaboration with A. Gallenkamp and Co., Ltd., 1952.) 5s. net. [102

British Gelatine and Glue Research Association. Third Annual Report for the Year October 1950 to September 1951. Pp. 13. Fourth Annual Report for the Year October 1951 to September 1952. Pp. 19. (London: British Gelatine and Glue Research Association, 1951–1952.) [102

Observations of Colour Temperatures of Stars. Vol. 2: Relative Gradients. Made at the Royal Observatory, Greenwich, in the Years 1926–1938, under the direction of Sir Frank Dyson and Sir H. Spencer Jones. Pp. iii+115. (London: H.M. Stationery Office, 1952.) 25s. net. [102

Department of Scientific and Industrial Research: Building Research Station. National Building Studies, Special Report No. 19: The Assessment of Vibration Intensity and its Application to the Study of Building Vibrations. By R. J. Steffens. Pp. iv+18. (London: H.M. Stationery Office, 1952.) 1s. net. [102

Birmingham Public Libraries. Periodicals in the Technical Library, Ratcliff Place, 1953. Pp. 20. (Birmingham: Central Library, 1953.) [102

Other Countries

Proceedings of the United States National Museum. No. 3288: An Annotated Check List of the Mosquitoes of the Subgenus Finlaya, Genus Aedes. By Kenneth L. Knight and Elizabeth N. Marks. Pp. 513–574. No. 3294: Australasian Stilt-legged Flies (Diptera: Tylidae) in the United States National Museum. By George C. Steyskal. Pp. 161–180. No. 3295: Aphotaenius, a New Genus of Lung Beetle (Coleoptera: Scarabaeidae). By O. L. Cartwright. Pp. 181–184. No. 3298: Moths of the Genus Mulona Walker and Lomuna, a New and Closely related Genus (Arctiidae: Lithosiinae). By William D. Field. Pp. 221–230. No. 3300: A New Genus of Central American Milliped (Family Euryuridae), with Notes on the American Genera. By Richard L. Hoffman. Pp. 235–244. No. 3303: A New Species of Insect of the Order Protura. By Grace Glance. Pp. 305–314. No. 3304: New American Cynipid Wasps from Galls. By Lewis H. Weld. Pp. 315–342. No. 3308: Moths of the Genus Epeiromulona, a New Genus of Lepidoptera. By William D. Field. Pp. 455–470. No. 3309: A Review of the Stink Bugs of the Genus Mecidea. By R. I. Sailer. Pp. 471–506. (Washington, D.C.: Government Printing Office, 1952.) [92

Smithsonian Institution: Institute of Social Anthropology. Publication No. 13: The Tajin Totonac. By Isabel Kelly and Angel Palerm. Part 1: History, Subsistence, Shelter and Technology. Pp. xiv+369+33 plates. (Washington, D.C.: Government Printing Office, 1952.) [92

Canada: Department of Mines and Technical Surveys. Geological Survey of Canada, Bulletin 22: Deep Wells and Subsurface Stratigraphy of part of the St. Lawrence Lowlands, Quebec. By Helen R. Belyea. Pp. v+113. 50 cents. Geological Survey of Canada, Memoir 265: Torbay Map-area, Newfoundland. By E. R. Rose. Pp. v+64. 75 cents. (Ottawa: Queen's Printer, 1952.) [92

Report of the King Institute of Preventive Medicine, Guindy, for the Period from 1st April 1950 to 31st March 1951, by Dr. Y. S. Narayana Rao, and Report of the Government Analyst, Madras, by Sri S. Narayana Ayyar. Pp. 103. (Madras: Government Press, 1952.) [92

Madras Government Museum. Guide Series No. 2: Guide to the Buddhist Antiquities. By A. Aiyappan and P. R. Srinivasan. Pp. x+58+3 plates. (Madras: Government Press, 1952.) 1.10 rupees. [92

Survey of India. Technical Report 1950 (from 1st April 1949 to 31st March 1950). Pp. v+55+3 plates+2 maps. (Dehra Dun: Survey of India, 1952.) 8 rupees; 12s. 9d. [92

First Annual Report 1951–52. Pp. 26. (Kjeller, pr. Lillestrøm: Joint Establishment for Nuclear Energy Research, 1952.) [92

Universal Copyright Convention. Pp. 24. (Paris: Unesco; London: H.M. Stationery Office, 1952.) 125 francs; 2s. 6d.; 50 cents. [92

Report on Scientific Results of the *Michael Sars* North Atlantic Deep-Sea Expedition, 1910. Vol. 4, Part 2, No. 2: Zoomorphi, Percomorphi, Plectognathi, from the *Michael Sars* North Atlantic Deep-Sea Expedition, 1910. By Einar Koefoed. Pp. 27+3 plates. (Bergen: A/s John Griegs Boktryckkeri, 1952.) [92

Protein Metabolism, Hormones and Growth: a Symposium. Six Lectures presented at the Eighth Annual Conference on Protein Metabolism, Bureau of Biological Research, Rutgers University, the State University of New Jersey, February 1–2, 1952. Pp. 80. (New Brunswick, N.J.: Rutgers University, 1953.) 1.50 dollars. [92

Meddelanden från Oceanografiska Institutet i Göteborg. 20: Étude minéralogique et morphoscopique de quelques sables des grands fonds de l'océan atlantique occidental. Par Solange Lapiaix et André Cailleux. Pp. 27. 21: On the Salinity of the Water contained in Marine Sediments. By B. Kullenberg. Pp. 38. (Göteborg: Elanders Boktryckeri A.-B., 1952.) [92

Ministry of Agriculture: Sudan Government. Memoirs of Research Division, No. 23: Pink Bollworm, *Platyedra gossypiella* (Saund.) as a Pest of Cotton at Zeidab, Northern Sudan. By H. S. Darling. Pp. 157–167. 10 plastres; 2s. Memoirs of Research Division, No. 24: The Genetics of Withering or Deciduous Bracteoles in Cotton. By R. L. Knight. Pp. 392–395. 10 plastres; 2s. (Khartoum: Agricultural Publications Committee, 1951–1952.) [92

Conseil Permanent International pour l'Exploration de la Mer. Annales biologiques, Vol. No. 8, 1951. Rédigé par A. Vedel Tåning, avec l'aide de Aa. J. C. Jensen. Pp. 186. (Copenhague: Andr. Fred Høst et fils, 1952.) 30 kr. [92

Sborník I Mezinárodního Polarografického Sjezdu v Praze (Proceedings of the 1 International Polarographic Congress in Prague). I.díl (Part) 3. Pp. 774. (Prague: Přírodovědecké vydavatelství, 1952.) 540 Kčs. [102

The Community Factor in Modern Technology: an International Study of the 'Sense of Belonging' in Industry. By Jerome F. Scott and R. P. Lynton. (Tensions and Technology Series.) Pp. 170. (Paris: Unesco; London: H.M. Stationery Office, 1952.) 300 francs; 6s.; 1 dollar. [102

Bulletin of the American Museum of Natural History. Vol. 100, Article 2: The Polyclad Flatworms of the Pacific Coast of North America. By Libbie H. Hyman. Pp. 265–392. (New York: American Museum of Natural History, 1953.) 1.50 dollars. [102

National Institute of Genetics. Annual Report No. 2 (1951). Pp. iv+70. (Misima, Japan: National Institute of Genetics, 1952.) [102

Kementerian Perhubungan: Djawatan Meteorologi dan Geofisik. Verhandelingen No. 42: Rainfall Types based on Wet and Dry Period Ratios for Indonesia with Western New Guinea. Edited by Dr. F. H. Schmidt and J. H. A. Ferguson. Pp. 77+3 maps. Verhandelingen No. 43: East Monsoon Fluctuations in Java and Madura during the Period 1880–1940. By Dr. F. H. Schmidt and J. van der Vecht. Pp. 36+1 map. (Djakarta: Djawatan Meteorologi dan Geofisik, 1952.) [102

Catalogues

Meteorological and other Scientific Instruments. (Catalogue No. 100B.) Pp. 50. (London: Short and Mason, Ltd., 1953.)

Automatic Voltage Regulators with Electronic Control. Pp. 12. (London: Zenith Electric Co., Ltd., 1953.)

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